SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING

SEPTEMBER 1899.

GENERAL PHYSICS.

1315. *Surface Tension by Ripples.* **L. Grunmach.** (Verh. Deutsch. Phys. Gesell. 1. pp. 13–22, 1899.)—The surface tension of liquids and of molten metals is determined by observing the interference waves produced by two vibrating centres connected respectively to the two prongs of a tuning-fork. Some of the results are given in the following table:—

	Temp. C.	Sp. G.	Surface Tension in Grammes per Centimetre.
Wood's alloy	145°	9·52	0·345
Rose's „	145°	9·34	0·350
Lipowitz's alloy	160°	9·58	0·334
Tin-lead „	215°	8·05	0·394
Tin	240°	6·988	0·359
Lead	335°	10·645	0·482

A. Gs.

1316. *Torsion.* **H. Bouasse.** (Journ. de Physique, 8. pp. 241–252, 1899.)—Confining himself to a loaded wire, the author lays great stress on the fact that the torsion produced by a given couple depends very decidedly on the mode of variation of the torsion with respect to time. Experiments which do not take the time into account are of little utility.

He shows how the behaviour of wires of the same material, but of different diameters, can be compared. Let R = radius of wire, a = angle of torsion, C = couple, t = time. Let θ be defined by the equation $\theta = Ra$. "Take wires of the same material, and of different diameters. Load them with weights proportional to their cross-sections. Give them any torsions whatever, a, in the inverse ratio of their radii, in such a way that, for all, the variable, $\theta = Ra$, has the same value. This determines that $d\theta/dt$ is the same at each instant for all.

"Drawing curves with $F = C/R^3$ as ordinates, and $\theta = R\alpha$ for abscissæ, however complex they may be, they reduce to a single one for all the wires. If the equation to the curve be $F = \phi(\theta)$, then $C = R^3 . \phi\,(R\alpha)$, applies to all the curves. Obviously there are as many curves as there are functions, $\theta = f_1(t)$, chosen."

A. Gs.

1317. *Flexibility of Baked Marble.* **P. Gamba.** (Roma R. Accad. Lincei Atti, 8 pp. 264–269, 1899.) The flexibility of marble at the ordinary temperature is measured (see 1899, Abstract No. 641); it is then heated to a higher temperature (100°–300° C.) for a few hours, and afterwards allowed to cool slowly to the original temperature. The operation augments the flexibility, the augmentation increasing with the temperature and with the duration of exposure. The residual deformation is also increased. A. Gs.

1318. *Source of Energy in Diffusive Connection.* **A. Griffiths.** (Phil. Mag. 47. pp. 522–529, June, 1899.)—Following up the work described in Abstract No. 406 (1899), the author here examines the source of energy of the convection in question, and traces it to the change of energy in the form of heat. E. H. B.

1319. *Apparatus for Determination of Rate of Diffusion.* **A. Griffiths.** (Phil. Mag. 47. pp. 530–539, June, 1899.)—This paper describes the apparatus it is proposed to adopt for the determination of the rate of diffusion of solids dissolved in liquids, and examines in detail the probable order of magnitude of the errors to which the apparatus is liable. E. H. B.

1320. *Van der Waals' Thermodynamic Theory of Capillarity.* **G. Bakker.** (Zeitschr. Phys. Chem. 28. pp. 708–718, 1899.)—The principle of thermodynamical equilibrium, due to Gibbs, may be enunciated thus: A substance arranges itself in a given space in such wise as to make (with given energy) the entropy a maximum. Gibbs states this principle in four different forms. Van der Waals, in his theory of capillarity, chooses the form which affirms that, at given temperature, $\int \rho(\epsilon - r_1\eta)\, dk$ is a minimum where ρ is the density, dk the volume element, and r_1 the temperature. The views of Van der Waals on this subject induced the present author to refer the problem of capillarity to purely statical and dynamical principles, and he thus obtains the same fundamental equation as was derived by Van der Waals by means of the principle of Gibbs.

E. H. B.

1321. *Barometer.* **Brunn.** (Zeitschr. Instrumentenk. Beib. 5. pp. 33–34, 1899.)—This is described as a standard barometer; its chief merit is that it is easy to fill. It is a syphon barometer of the Gay-Lussac shape, the turned-up lower arm of the syphon being rather longer than usual, and wider than the other part of the tube. The top of the other arm is also widened out into a vertical bulb, above which there is a horizontal **S**-bend and a third vertical bulb having inserted in it a tube closed by a stop-cock. To fill the barometer, mercury is first poured in at the open turned-up end of the lower arm. An ordinary air-pump connected to the top tube then sucks mercury up into the second bulb. The stop-cock is then closed, and the barometer is tilted so as to fill the **S**-bend and the third bulb. If now the barometer is once more held perpendicular the **S**-bend entraps some of the mercury, leaving a vacuum in the first bulb. R. A.

1322. *Slipperiness of Ice.* **O. Reynolds.** (Mem. Manchester Lit. & Phil. Soc. 43. 5. pp. 1–7, 1899.)—This is a popular exposition of the cause of the slipperiness of ice, based upon the lowering of the melting-point by pressure and the formation of a very thin liquid film. E. E. F.

1323. *Motions of the Ether.* **G. Mie.** (Wied. Annalen, 68. 1. pp. 129–134, 1899.)—Assuming that the energy of an ether particle is made up of the sum of its electric, magnetic, compressional, and kinetic energies, the author proves that the vortex lines of the ether currents always coincide with those of Poynting's energy current. Helmholtz's assumption that the ether is free from inertia does not agree with the fact that Poynting's vector possesses vortex points. If the density of the ether exceeds 10^{-9} it is generally possible to neglect the effect of ether currents in the evaluation of the electric field. The cases in which Poynting's energy current is cyclical are specially convenient. In these the field is generated by the superposition of an electrostatic and a magnetic field. Such a field was used to determine at least a lower limit for μ. Two condensers were brought into a powerful magnetic field, so that the electric lines of force were at right angles to the magnetic ones. The difference in the velocity of light in the two condensers, reversed with respect to each other, was observed by means of an interference refractometer, but that difference was so small as not to be within the range of the instrument, and μ is in any case greater than 10^{-10}. But it does not follow that the ether is rigid. E. E. F.

1324. *Variations of a System in Motion.* **Natanson.** (Zeitschr. Phys. Chem. 26. pp. 285–306, 1898, out of the pölnischen, Rozprawy Wydz. M. P. Akad. Wm. W. Krakovie.)—The author here considers a system of two homogeneous substances which do not mix but transfuse freely into each other. The one is contained in a volume V the other in a volume V′. V and V′ have part of their respective bounding surfaces Σ in common; V is entirely bounded by S and Σ, V′ by S′ and Σ. The author applies the "thermokinetic principle," that is if T denote kinetic energy, F free energy, W work done by external forces, and $\delta' Q$ a quantity of heat absorbed by the system, then—

$$\int_{t_0}^{t_1} dt\,(\delta T - \delta F + \delta W + \delta' Q) = 0,$$

an expression analogous to the ordinary—

$$\int_{t_0}^{t_1} dt\,(T - U) = 0,$$

i.e., to the principle of stationary action. He treats, firstly, the case in which there is no friction and $\delta' Q = 0$; secondly, the case in which there is friction and $\delta' Q$ has to be taken into account. Finally he discusses an example of a stream of water passing over ice.

In a later memoir on the thermokinetic properties of solutions (Bulletin de l'Academie de Sciences de Cracovie, Juillet, 1898), Natanson extends the theorem to the case in which one of the two substances is an aqueous solution of a salt, and the other may be water ice or vapour of water, or the salt itself or a foreign substance, and obtains analogous results. S. H. B.

1325. *Flying.* **M. F. Fitz-Gerald.** (Roy. Soc. Proc. 64. pp. 420–430, 1899.)—The paper is mathematical; and, to quote the words of the author, "an attempt is made to indicate how both progressive and hovering flight may be effected by aëroplanes, attached to a heavy mass, and flapped after the manner of wings, under conditions sufficiently nearly approaching those of Langley's experiments to justify the inference, from his figures, of numerical results, not indeed presumably correct, but sufficiently indicating the order of magnitude of the quantities involved."

The power required is much less than that given by older theoretical investigations. The present treatment indicates that a bird, for each pound of its weight, may be able to fly with a power of two or three ft.-pounds per second. A. Gs.

LIGHT.

1326. *Light Plane Mirrors.* **A. Mallock.** (Roy. Soc. Proc. 64. pp. 440–442, 1899.)—Mirrors are described made of thin floating pyroxyline films made to adhere across worked rings, and silvered. A. D.

1327. *Telescope Objectives.* **E. v. Höegh.** (Zeitschr. Instrumentenk. 19. pp. 37–39, 1899.)—A simplification of Dr. Harting's investigations and methods (see 1899, Abstract No. 786). By taking a focal length instead of a radius of curvature as the unknown, the expressions become manageable instead of being applicable only by approximation. A. D.

1328. *Fraunhofer's Objectives.* **H. Krüss.** (Zeitschr. Instrumentenk. 19. pp. 74–77, 1899.)—Discussion, in the light of recent determinations by S. v. Merz of the refractive indices of the glass, of Fraunhofer's methods of chromatic correction as exemplified in the Königsberg heliometer objective and three others. A. D.

1329. *Gold and Platinum Mirrors.* **G. Breithaupt.** (Wied. Annalen, 68. 1. pp. 46–73, 1899.)—To avoid the disturbing effects of polishing materials, the author produces burnt-in mirrors of gold and platinum on glass or obsidian from the commercial solutions of gold and platinum salts in ethereal oils. He then determines their refractive indices from the chief angle of incidence and the chief azimuth. Gold gives good and constant values, which accord well with the results of previous observers. The constants of the gold mirrors do not vary even during months after their preparation, and the mirrors are therefore very suitable for reflection observations. The absence of bismuth in the gold solution increases both the chief azimuth and the principal angle of incidence. Platinum mirrors are not so satisfactory, and no definite constants can be obtained from the burnt-in mirrors. They show anomalous dispersion, whereas the gold is normal. When gold and platinum are mixed, a preponderance of gold increases the chief azimuth. Steel and nickel steel mirrors show anomalous dispersion. Brass, brought to highest brilliance by long polishing with cotton, disperses normally. E. E. F.

1330. *Total Reflection.* **W. Voigt.** (Wied. Annalen, 68. 1. pp. 135–136, 1899.)—In reply to Ketteler's criticism, the author maintains that according to the universally accepted theory of total reflection there is a stream of energy which is propagated into the rarer medium at the maximum incidence, but that stream is parallel to the surface of separation. Such a stream of energy must, after Kirchhoff and Maxwell, be regarded as a ray, and that is the tangential ray observed by the author. E. E. F.

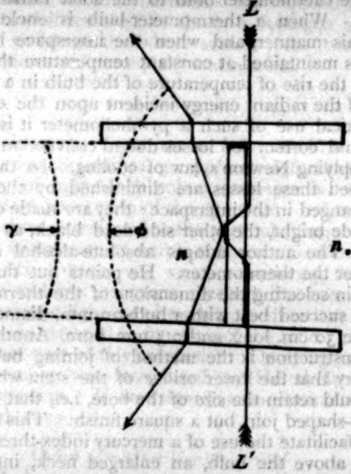
1331. *Instruments for Crystallography.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 19. pp. 4–18, 1899.)—Apparatus described for applying total reflection methods to the study of small or imperfect crystal-faces in practical crystallography. A. D.

1332. *Refractometer.* **H. Starke.** (Verh. Deutsch. Phys. Gesell. 1. pp. 117–122, 1899.)—If a ray of light traversing a medium of refractive index μ falls upon a parallel plate of a second substance of refractive index μ_1 of thickness d, at an angle of incidence a, it is displaced parallel to itself through a distance x; where—

$$x = \frac{d \sin a \left[\sqrt{\mu_1^2 - \mu^2 \sin^2 a} - \mu \cos a \right]}{\sqrt{\mu_1^2 - \mu^2 \sin^2 a}}.$$

By constructing an apparatus in which d, a, and μ are constant, the value of μ_1 can be found by a measurement of x. The author applies this method in order to find the refractive index of liquids, using an ordinary microscope. A short vertical glass tube, slightly conical, is provided with a two-part glass stopper; the space between the two parts is formed by separated plane surfaces parallel to one another at an angle of 45° with the axis of the stopper. Both ends of the stopper are squared off flush with the tube. The lower part of the stopper is fixed; the upper part can be removed so that the space can be filled with the liquid whose refractive index is required. This apparatus is then fixed under the objective of a microscope, with a glass scale beneath it. In order to reduce the errors of observation such as would arise if the reading of x were taken directly, it is better to observe $2x$; this is done by keeping the scale fixed, and then, having read the scale with the apparatus in one position, the glass tube is turned about its axis through 180° and a second reading is taken. With a small refractometer of this kind, providing for a thickness of liquid of 0·5 c.m., the author is able to determine the indices to the third place of decimals with certainty; he even goes so far as to estimate to the fourth place. The above expression for x shows that the measurement assumes a constant value for the ratio of μ_1 to μ. This means that the values obtained are only correct so long as the liquid and the glass are of the same colour. R. A.

1333. *Trough Refractometer.* **W. Hallwachs.** (Wied. Annalen, 68. 1. pp. 1–45, 1899.)—The author describes and tests a method of measuring small differences of refractive index without an interference refractometer. He uses glancing incidence upon a partition separating the two liquids to be compared. Light from a sodium burner enters the double trough from L and L′, and the angle ϕ between the emergent beam is measured. If γ is the angle between the two faces of the trough—it should only be a few seconds—then the difference of refractive power is given by the equations



$$n - n_0 = \frac{\sin^2 a}{n + n_0}$$

$$a = \frac{180 - \phi}{2} \pm \frac{\gamma}{2}\left(\frac{n_0}{\cos \frac{1}{2}(180 - \phi)} - 1\right)$$

The upper sign is used if the liquid whose refractive index is n is situated towards the vertex of γ.

The accuracy of the method is such that the refractive index with respect to water may be found to within a millionth of its value. The author uses the method for determining the relation between refractive index and concentration in aqueous solutions of $CdBr_2$, sugar, di- and tri-chloracetic acids, and their potassium salts. E. E. F.

1334. *Alcohol Actinometer.* **A. Crova.** (Annal. Chim. Phys. 17. pp. 22–38, 1899.)—The intensity of solar radiation is calculated from the readings of a thermometer whose spherical black bulb is concentric with a metal sphere with a small window in it. The instrument is kept in partial shadow by two diaphragms of polished metal having a central orifice which exposes only one sq. cm. of the thermometer-bulb to the solar radiations through the window. When a thermometer-bulb is enclosed and protected in this manner, and when the interspace between bulb and sphere is maintained at constant temperature throughout an observation, the rise of temperature of the bulb in a given time is a measure of the radiant energy incident upon the exposed area. In the practical use of such a pyroheliometer it is necessary to determine and correct for losses due to convection and counter-radiation, applying Newton's law of cooling. In the instrument here described these losses are diminished by the use of thin reflectors arranged in the interspace; they are made of aluminium sheet, one side bright, the other side dead black, as in Langley's bolometer. The author adopts absolute-alcohol as the liquid best suited for the thermometer. He points out that great care is necessary in selecting the dimensions of the thermometer; his experiments succeed best with a bulb 20 mm. diameter, having a capillary tube 30 cm. long, and 0·3 mm. bore. Another important detail of construction is the method of joining bulb and stem. It is necessary that the lower orifice of the stem where it enters the bulb should retain the size of the bore, *i.e.*, that there should be no funnel-shaped join, but a square finish. This arrangement, intended to facilitate the use of a mercury index-thread, is secured by blowing, above the bulb, an enlarged neck, into which the capillary tube is sealed with a square internal shoulder. An observation consists of three readings. After the preliminary setting the instrument is left in shadow for one minute, and then the thermometer is read. The instrument is then immediately exposed for two minutes and the second reading is taken. The screen is now closed, and after another two minutes the third reading is noted, and the operation is complete. Incidentally, the author strongly recommends that thermometer bulbs for radiation work should be blackened by a coating of electro-deposited copper, afterwards treated with platinic chloride. R. A.

1335. *Restoration of Photographic Plates.* **E. Andréoli.** (Électricien, 17. pp. 152–154, 1899, and Elect. Rev. 44. p. 326, 1899.)—These two articles are practically identical; they describe experiments based on an observation recorded by Emerson Reynolds in the Proceedings of the Dublin Chemical and Philosophical Club for 1867, which was that when an exposed undeveloped photographic plate was submitted to the action of ozone the image could not be developed, but that the plate was available for re-exposure. If ozone is thus able to destroy a latent image, the author concludes that it should be able to restore a fogged plate. The assumption is that ozone oxidises the silver compounds which light has reduced. Two dry plates were wrapped one half of each in tin-foil, and then exposed to brilliant sunlight for two seconds. They were then taken into the dark-room and ozonised for four minutes. Subsequently they were used, with the tin-foil removed, to obtain a Röntgen photograph. The image was visible on the whole surface; the two halves of the plate were, however, not equally transparent. R. A.

1336. *Monochromatic Light as a Damped Vibration.* **A. Rovida.** (Rivista Scientifica, 30. pp. 225–236, 1898.)—In the classical theory of light, each colour corresponds to a definite frequency and to a linear strip of the spectrum: indices of refraction for each colour correspond to the particular frequencies: and white light is a summation of simple colours. Garbasso in 1894 (Atti R. Acc. Sci. Torino, vol. xxx.), considering the Hertzian phenomenon of multiple resonance, reached the conclusion that while monochromatic light may be a simple vibration, white light may be a vibration damped in function of the time. The author rejects the former part of this conclusion. Damping as a function of the displacement was introduced by Helmholtz to explain anomalous dispersion. If we regard monochromatic light as doubly damped, thus—

$$A\,.\,\epsilon^{(k+h\sqrt{-1})y+(l+m\sqrt{-1})t}$$

compound light remains the sum of the different colours, depending on the squares of the amplitudes, and the only lights capable of interfering with one another are those of the same colour In the spectrum, the "line" for each colour must still have some breadth, else (Galileo) it would not be visible; but this points to continuous damping in function of time or of displacement. The former of these, expansive damping, when considerable, gives Lommel's results as to widening of spectral lines: the latter, dispersive damping, gives rise to anomalous dispersion. Neither of these can, however, be completely suppressed. The alleged continuity of the spectrum is analogous to the imaginary continuity of water in hydrodynamics. Hertzian waves are given out with single wave-lengths (Hertz, Bjerknes, Le Royer, Berchem), but the resonator shows multiple resonance, which is analogous to a broadening of a spectral line. The impression on the eye seems to show that harmonic vibration, coexisting, may affect the colour-sensation produced: and anatomical peculiarities, pointed out by von Helmholtz, may be explained on the basis of the closest analogy between the ear as a receptor for sound and the eye as a receptor for light: the analogue of the organs of Corti being the various component fibrillules of the rods and cones of the retina. These would have, in any case, to be extremely slender in order to meet the requirements of the short wave-lengths: and if independent they would be too fragile; so that, being bound together, they hamper one another's independence of action and fall short in resolving power. But the greater the brightness the greater would be the disturbance of the fibrillules not primarily sensitive to the wave-lengths of the incident light, which would affect the resultant colour-sensation up to the standard of white light. Such a receptor would manifest multiple resonance analogous to that of Hertzian waves. This does not necessarily affect Young's theory of three primary colours. A. D.

1337. *Width of Slit in Interference Experiments.* **J. Walker.** (Phil. Mag. 46. pp. 472–478, 1898.)—A mathematical investigation. The angle subtended by the slit at the interference apparatus must be a small proportion of that subtended by the width of the bands at the same point. When the variations of the width of the bands are due to variations of the distances of the slit and screen of observation from the apparatus, as the bands become finer the slit may be made wider without loss of distinctness. A progressive widening of the slit causes a periodic disappearance of the bands, the system of bands at the successive reappearances being alternately bright and dark centred. A. D.

1338. *Thickness of the Black Spot in Liquid Films.* **E. S. Johonnott, Jr.** (Phil. Mag. 47. pp. 501–522, June, 1899.)—In the work here described two methods suggested by Michelson were used, one by an interferometer, the second, photometric. The author concludes (1) that the thickness of the black film of a soap solution may vary between 6 $\mu\mu$. and 40 $\mu\mu$. (where $\mu\mu. = 10^{-6}$ mm.); (2) that the film of a pure oleate solution may consist of two black films, the thickness of the second being about half the limiting thickness of the first, which is about 12 $\mu\mu$. E. H. B.

1339. *Polarisation of Diffused Light.* **A. Lafay.** (Annal. Chim. Phys. 16. pp. 503–562, 1899.)—The researches were suggested by the work of de la Provostaye and Desains upon the diffusion of heat. In order to complete the results obtained with heat rays they studied the action of dull surfaces upon natural and upon polarised light. Generally speaking, the light obtained by the diffusion of a polarised beam presents the character of a mixture of natural and elliptically polarised light, in which the proportion of the latter may attain a considerable value. The diffusing bodies may be divided into two classes. One of them, represented by glass and dull metals, diffuses light by virtue of the roughness of the surface. The other, represented by marble and porcelain, diffuses light in addition through partial absorption and emission by particles suspended in a transparent mass. The author has concentrated his attention upon the first class as offering simpler phenomena. He gives a method of comparing the state of polish of different surfaces, based upon the smallest angle of incidence at which the surface will produce a clear reflected image. He finds that MacCullagh's relation, viz., $\sin\delta \tan 2\gamma = \text{const.}$, which applies to reflection by a polished metal, has its counterpart in a similar relation in the case of diffused reflection. E. E. F.

1340. *Magneto-Optic Phenomena.* **E. Ketteler.** (Wied. Annalen, 68. 1. pp. 125–128, 1899.)—The author explains the phenomena observed by Macaluso and Corbino, and by Becquerel, by the mathematical theory of magneto-optic phenomena worked out by him as long ago as 1882. That theory did not, however, comprehend the cases observed by Zeeman, and the author acknowledges that the more comprehensive Hertzian equations are required for effectively dealing with the latter. E. E. F.

1341. *Zeeman Effect.* **A. Righi.** (Roma R. Accad. Lincei Atti, 8. pp. 325–326, 1899.)—Fitzgerald suggests that a circularly polarised ray sent through a powerfully absorbent gas should render it appreciably magnetic—a sort of converse Zeeman effect. The experiment is not novel, having been made by the author in 1883, and by Gray in 1890. The author has tried bromine and gaseous N_2O_4, which give Zeeman effects at ordinary temperatures; but there is no trace of a magnetic field, at any rate as powerful as 10^{-6} C.G.S. unit. A. D.

1342. *Zeeman's and Faraday's Phenomena.* **W. Voigt.** (Göttingen, Nachrichten, 4. pp. 329–344, 1898.)—Faraday's magnetic rotatory polarisation and Zeeman's phenomenon are related in this way, that when we consider the inverse Zeeman phenomenon of alteration of selective absorption of a body in the magnetic field, the Faraday effect is found to depend on the relative velocities, while the inverse Zeeman effect is found to depend on the relative absorbabilities acquired by the two oppositely rotary circularly polarised components of natural light traversing the field; so that the inverse Zeeman phenomenon is nothing other than the Faraday phenomenon in substances possessed of selective absorption. In the case of light crossing the lines of force this relation seems to disappear, for the Faraday effect in this case is apparently absent. The author develops mathematically an explanatory theory of which the Faraday and the Zeeman effects work out as special cases, provided that the Faraday phenomenon in respect of rays across the line of force is not null but produces a very slight ellipticity of the incident plane polarised light. A. D.

1343. *Sodium Vapour in Magnetic Field.* **W. Voigt.** (Göttingen, Nachrichten, 4. pp. 355–359, 1898.)—Sodium vapour in a magnetic field becomes double refracting in directions normal to the lines of force, in a way which may be predicted from the author's explanation of the Faraday and Zeeman phenomena. (See preceding Abstract; also 1899, Abstract No. 999.) A. D.

1344. *Anomalous Dispersion.* **Rayleigh.** (Phil. Mag. 48. pp. 151–152, July, 1899.)—The author shows that Maxwell had considered this question as early as 1869. Maxwell's results are given in a question set in the Math. Tripos examination for that year at Cambridge. He supposes a medium whose elasticity is defined as follows, viz., a tangential displacement η in direction y of a stratum of thickness a calls into play a force of restitution $E\eta/a$ per unit area. Then a system of atoms of other matter such that every part of the medium is connected by an attractive force varying as the distance, and there is also a resistance between the medium and the atoms varying as their relative velocity, the atoms being independent of each other. Hence is obtained the equation of propagation of waves in the compound medium. Let σ be the density of the atoms per unit volume, ρ that of the medium; also let $\sigma p^2\zeta$ be the attraction, and $\sigma R d\zeta/dt$ the resistance; then, if σ be very small, the result given is $\mu^2 = \frac{v_0^2}{v^2} = 1 + \frac{\sigma}{\rho}\frac{p^2}{p^2 - n^2}$ where n denotes the periodic time, and v_0 the velocity when $\sigma = 0$.
S. H. B.

1345. *Spectra of Hydrogen.* **T. W. Richards.** (Chem. News, 79. pp. 159–160, 1899.)—In a recent paper (Phil. Mag., September, 1898) Hutton recounts some interesting experiments which tend to show that Hasselberg's "white spectrum" of hydrogen really belongs to that substance and not to impurities. One point he was unable wholly to explain—the fact that Cornu and he always obtained a brilliant red four-line spectrum of hydrogen whenever a trace of oxygen was present. The experience recently gained by Trowbridge and the author furnishes the data for an explanation of the matter.

Water vapour under diminished pressure gives the pure red spectrum far more readily than hydrogen itself does, and when aqueous vapour is mixed with elementary gases it seems usually to conduct the electricity by itself. This fact (that water vapour conducts electricity easily) may be accounted for by its heterogeneous molecular constitution, which is more sensitive to electric stress than the homogeneous structure of the hydrogen molecule. Water must have been formed in Hutton's and Cornu's tubes, and this must have been the source of the red spectrum. From the above and other arguments the author supposes the red spectrum is due to dissociated atoms of hydrogen, or to the disturbance in the act of dissociation, while the white spectrum is due to the rupture of polarised particles. It is obvious that only the characteristic lines of atomic hydrogen, not those of molecular hydrogen, could be obtained from water, and these are obtained so easily that the molecular spectrum of water steps into the background. On the other hand, if hydrogen is perfectly dry, the red spectrum requires tremendous heat for its appearance in a state of purity—a circumstance which hypothesis explains simply by ascribing great stability to the polarised molecular structure of the gas. J. B. H.

1346. *Absorption Spectra of Gases.* **P. Baccei.** (N. Cimento, 9. pp. 177–191, 1899.)—Various gases were experimented upon in an iron tube 25 m. long, consisting of several parts screwed together and sealed with marine glue. A beam of light from an incandescent lamp was sent through the tube and twice reflected through it by plane mirrors, so that it traversed it three times, thus increasing the effective thickness of gas traversed to 75 m. Pressures up to 20 atmospheres were used. Carbonic acid showed no trace of an absorption spectrum even at the highest pressure. Neither did nitrogen or carbonic oxide. But acetylene showed a band in the red (6842 to 6815) and several lines in the orange, yellow, and green, the brightest being at 6395. The oxygen lines at A and B were observed at a pressure of 14 atmospheres. In the case of hydrogen sulphide the pressure could not be raised beyond 12 atmospheres, owing to the liquefaction of the gas. But a somewhat feeble band was observed in the red (6735 to 6781). E. E. F.

1347. *Broadening of D-lines.* **H. Wanner.** (Wied. Annalen, 68. 1. pp. 143–144, 1899.)—The author describes a curious spectroscopic phenomenon produced by burning a sodium bead inside a sphere having an inner reflecting surface, but a silvered glass sphere on the outside, which may consist of two hemispherical caps. In the spectroscope the sodium lines appear strongly broadened out, and accompanied by a feeble continuous spectrum reaching into the green and the red. The lines are also once or twice reversed. A somewhat similar phenomenon may be obtained by placing several Bunsen burners one behind the other, but it is then feebler. E. E. F.

1348. *Energy in the Spectrum of a Black Body.* **F. Paschen.** (Berlin Akad. Sitzber. 22. pp. 405–420, 1899.)—The author refers to experiments made by himself (Wied. Ann. 58. S. 455, 1896, 60. S. 662, 1897), from which it appears that the emission of the "absolutely black body" is represented by Wien's formula—

$$J = c_1 \lambda^{-5} \epsilon^{-\frac{c_2}{\lambda T}} \qquad (1)$$

in which $J d\lambda$ is the energy of that part of the spectrum between wave lengths λ and $\lambda + d\lambda$, T is the absolute temperature, and c_1, c_2 are constants. Generally for λ^{-5} we might use $\lambda^{-\alpha}$. Now Wien obtains the following results: Firstly, that if J_m be the maximum value of J, then J_m varies as the fifth power of the temperature, which is satisfied by making $\alpha = 5$ in (1). Secondly, if λ_m be the wave-length for maximum J, then λ_m varies inversely as the temperature. Thirdly, J/J_m is a function, and always the same function, of λ/λ_m. The author obtains the equation—

$$\log J/J_m = \alpha \log \lambda/\lambda_m + \alpha\,(1 - \lambda_m/\lambda).$$

He compares Wien's results with his own experiments, which are described in the memoir. S. H. B.

1349. *Balmain Luminous Paint.* **L. Kann.** (Phys. Rev. 8. pp. 250–251, 1899.)—In the hope of finding, if possible, a process of recording very short Hertzian waves of 1 or 2 mm., the author experimented with Balmain luminous paint, thinking that the fluorescence caused by light of comparatively short wave-length might be annulled by Hertz rays among other rays of greater wave-length. In this he was not successful, but other interesting radiation phenomena were noticed. Upon a frame of cardboard were mounted strips of different materials which were crossed by other strips. This frame was then placed on a photographic plate in a light-tight box and over it was laid the screen, which for some time (one-half hour to six hours) had been exposed to the direct sunlight. This plate was left in the box for different spaces of time (from one-half minute to a few days). It was found that while the light very easily passed through several layers of white paper it did not pass nearly so easily through black paper. It was, indeed, possible to print on the photographic plate very plainly within half a minute the name on a visiting card enclosed in a very heavy envelope.

Objects placed upon the black paper also showed their contours upon the plate, but only after a long exposure. The different strips referred to above showed different transparencies which, however, have not yet been arranged in any definite succession. Cardboard, wood, and aluminium appeared to be especially transparent. Printed letters on a card were sharply photographed even through a sheet of aluminium.

These effects must be due to the radiation of the Balmain paint and not to the vapours of the materials of which the strips are composed, for the same strips were placed upon a photographic plate and exposed five days without obtaining any blackening of the film. Some of the results, it is true, might be explained by the transparency of some of the strips to the rather intense visible light emitted by the screen, but further experiments showed that screens which had been kept in a dark room for one or two days, although the luminosity ceased after five to six hours, gave essentially the same results. E. E. F.

1350. *Change of Absorption produced by Fluorescence.* **J. Burke.** (Phil. Trans. 191. pp. 87–104, 1898.)—An account of experiments which show that fluorescent bodies absorb differently, according as they are fluorescing or not, the rays which they give out whilst fluorescing. When light from a body B, which is fluorescing, is caused to fall upon a similar body A, the amount of light apparently transmitted by A is very different according as A is fluorescing or not, the amount in the experiments described being very much less, only about one-half, when fluorescence is taking place than when the body is unacted upon by exciting light. The amount of fluorescent light given out by A does not appear to be increased or diminished by the incident radiation from B, but an increased direct absorption occurs.

J. J. S.

1351. *Therapeutic Use of Crookes Tubes.* **F. de Courmelles.** (Paris Soc. Franç. Phys. Bull. 123. pp. 2–3, 1898.)—Experiments shown as to medical exploration, of cavities of the body or otherwise, by radiophotography rendered painless by putting the bulb of the Crookes tube to earth so as to limit the electric field. The tubes also last longer and are more readily worked.

A. D.

1352. *Transformation of Röntgen Rays.* **R. Malagoli** and **C. Bonacini.** (N. Cimento, 9. pp. 279–295, 1899.)—The authors have concluded that different substances may be divided into three groups: A, those which act as simple diffusers of incident Röntgen rays; B, those which act as transformers of these rays; and A-B, bodies which act partly in both these ways. Sagnac, on the contrary, concludes that all bodies belong to group B, and that there is no diffusion of Röntgen rays; that the rays transformed by different bodies differ in their penetrative power and also in their absorbability by air; and that Röntgen rays after transmission through a body are always accompanied by some transformed rays. This paper is devoted to a consideration of the advantages of the authors' photo-plate method of working, as against Sagnac's electroscope method; to a detailed criticism of Sagnac's methods and results; and to a re-affirmance of their former proposition, to which in fact Sagnac has recently approximated. They say there is no evidence that transformed rays are absorbed by air at all; that it has not been conclusively shown that there is any appreciable difference in kind between the incident fasciculus and that disseminated by any body, and that if there be it has not been shown that this is due to a transformation of all the rays rather than of some of them. A. D.

1353. *Deflection of Röntgen Rays behind an Obstacle.* **R. Malagoli** and **C. Bonacini.** (Roma R. Accad. Lincei Atti, 8. pp. 296–302, 1899.)—A critical summary. Conclusion, that there is no true deflection, the apparent deflection being due to diffusion or to secondary rays by transformation. A. D.

HEAT.

1354. *Permanent Changes and Thermodynamics.* **P. Duhem.** (Zeitschr. Phys. Chem. 28. pp. 577–618, 1899.)—The author discusses the properties of systems which depend on a single normal variable, with especial relation to the rupture of elastic bodies. In his first chapter he deals with systems which are defined by a single normal variable besides temperature, to which class belongs sulphur treated of in his former work (Zeitschrift, 23, 193). Systems may be of the first or second kind, the first kind consisting of those whose natural conditions are permanent. He investigates isothermal cyclic processes, expressing the result by curves on the diagram on which the external conditions are defined by the abscissæ; and the distinction is shown between bodies of the first and of the second kind. The second chapter, concerning the rupture of elastic bodies, deals with systems which may belong in part to the first and in part to the second kind. He discusses (1) the form assumed by the lines defining the state of an unstretched wire when the wire is stretched; and (2) the rupture of a stretched wire, referring to works by Dufour, Poucelet, and Kennedy. S. H. B.

1355. *Joule-Thomson Thermal Effect.* **E. F. J. Love.** (Phil. Mag. 48. pp. 106–115, July, 1899.)—The results obtained by Kelvin and Joule in their classic experiments have hitherto been utilised almost exclusively for determining the relation between the various gas scales and the absolute, or work, scale of temperature. The present paper deduces from the same results other consequences. If the ordinary Boyle-Charles equation of a perfect gas be differentiated, it can be shown that the Joule-Thomson effect is zero, which is disproved by the experiments. If, on the other hand, Van der Waals' equation—

$$\left(p+\frac{a}{v^2}\right)(v-b)=\mathrm{RT}, \qquad (1)$$

be taken as the characteristic of a gas, it can be shown that

$$\theta=\frac{\alpha}{\mathrm{T}}-\beta \qquad (2)$$

where θ is the Joule-Thomson cooling effect per atmosphere, T is the absolute temperature, α and β are constants. This is exactly the formula proposed by Rose-Innes, from an examination of the experimental results of Joule and Kelvin, but is here seen to be deducible from Van der Waals' equation. The author also shows that the following relations hold: (1) The Joule-Thomson effect is zero for every substance at its maximum density, just as it is for an ideal perfect gas, though for a very different reason; (2) the *infinite number* of specific heats which every substance possesses is reduced at this point to *one*. E. H. B.

1356. *Thermal Conductivity of Water.* **S. R. Milner** and **A. P. Chattock.** (Phil. Mag. 48. pp. 46–64, July, 1899; Rep. Brit. Assoc. p. 808, 1898.)—Heat is generated by the passage of an electric current through a platinum wire resistance threaded in zigzags on a mica disc so as to cover the flat circular bottom of a vessel which is separated by a layer of liquid, of easily varied thickness, from the flat top of a copper vessel through which cold water continuously flows. This bottom is made of thin microscope cover-glass which is covered on top with tinfoil cut in concentric rings and insulated by paraffin waxed paper from the heating grid: the distribution of heat-flow is thus equalised and lateral flow prevented without the use of an excessive thermal resistance. All temperatures are measured thermoelectrically, and to ensure that all the heat from the grid flows downwards the grid is packed above with cotton-wool with a compensating coil, the temperature of which is kept always the same as that of the grid. The method of measurement employed is differential. If θ_1, θ_2 are the differences of temperature between the grid and the copper vessel for thicknesses x_1, x_2 of the intervening liquid when C is the current flowing, R and A being the resistance and area of the part of the grid used, then the thermal conductivity is given by

$$k=0{\cdot}2406\ (C^2R/A)\,(x_2-x_1)/(\theta_1-\theta_2).$$

For greater exactness two apparatus of exactly similar make were employed, which were first adjusted to give the same value of θ_1, and the reading θ_2 of one of them which was altered was then compared with the reading θ_1, given simultaneously by the other, which remained unaltered. For further details the paper must be referred to. The final mean value of k for water at 20° C. was found (see an erratum) to be 0·001433 C.G.S. unit. R. E. B.

1357. *Thermal Conductivity of Cast Iron.* **E. H. Hall** and **C. H. Ayres.** (Amer. Acad. Proc. 34. pp. 283–308, 1899.)—By experiments on a disc of 10·06 cm. radius and 1·787 cm. thickness, with temperature-differences measured thermoelectrically, the thermal conductivity of the cast iron used (the analysis of which gave about 3·50 carbon, 0·53 manganese, 0·056 phosphorus, 0·053 copper, 0·106 sulphur, 1·40 silicon) appears to be 0·1490 at 30° C., and to have a temperature-coefficient between 20° and 75° of −0·0010 if the specific heat of water is taken to be constant, but of −0·00075 if Winkelmann's rule for the variation of the specific heat of water with temperature is correct.

The electric conductivity of this cast iron is about 112200 C.G.S. units at 17·4°, with a temperature-coefficient of −0·00118 between 17° and 67°.

The paper contains full details of the method employed and the precautions necessary, as well as an appendix in which the determination of the thermoelectric quality of the cast iron relatively to copper is described. R. E. B.

1358. *Thermal Insulation.* **W. Hempel.** (Wied. Annalen, 68. 1. pp. 137–138, 1899.)—The author compares the Dewar vacuum insulator with some of the older types of thermal insulators, by immersing test tubes filled with a mixture of ether and solid carbonic acid in them, and finding how long they maintain the test tubes at −79°. The improved Dewar tube, silvered on the outside, gave of course the best results, the temperature being still as low as −70° after eighty-eight minutes. Less exhausted vacuum tubes allowed it to rise to −33° in the same time, while tubes packed in wool, cotton, or silk showed −45° to −55°. Eiderdown proved itself a very good insulator, as it kept the temperature down as low as −66°. E. E. F.

1359. *Conduction of Heat in Air.* **Rayleigh.** (Phil. Mag. 47. pp. 314–325, 1899.)—This is a mathematical paper, in Fourier form, dealing with the conduction of heat in air confined by walls at constant temperature, the circulation due to gravity being neglected and also the inertia of the motions due to local expansions and contractions, so that the pressure at any moment is taken as uniform throughout the mass. It is thus given by

$$p = k\rho\,(1 + s + \alpha\theta),$$

where s is the condensation and θ the excess of temperature, with the proviso that these variables are of the form $s = \sigma \exp(-ht)$, $\theta = \tau \exp(-ht)$, where σ, τ are independent of the time t and are connected by the relation $\sigma + \alpha\tau = \text{const.}$ The equation to integrate is

$$\dot\theta - \dot s\,(\gamma - 1)/\alpha = \nu\nabla^2\theta - q\theta,$$

where γ is the ratio of the specific heats, ν the thermometric conductivity, and q the radiation-coefficient, the radiation being supposed to be proportional to θ; and it at once reduces to the form

$$\nabla^2\tau + m^2(\tau - c) = 0.$$

The author works out three cases: (1) when there is no conduction, or $\nu = 0$; (2) when the gas is enclosed between parallel planes with symmetry on the two sides of the mid-plane, the simple case corresponding to no radiation, or $q=0$, being completely solved; (3) when the enclosure is spherical, surface harmonics and Bessel's functions being now involved in the solution; in this last case the term of zero order in spherical harmonics (*i.e.*, that characterising symmetry about the centre) is specially considered and is fully developed for $q=0$. R. E. B.

1360. *Liquid Air.* **F. Dommer.** (Revue Scientif. 11. pp. 385–391, 1899.)—An interesting summary of the methods of obtaining liquid air and of its applications. A. Gs.

1361. *Jena Glass Thermometers.* **H. Lemke.** (Zeitschr. Instrumentenk. 19. pp. 33–37, 1899.)—Investigation, with tabulated results, as to the corrections requisite in mercury thermometers of Jena glass 59^{III} between 100° and 200°. A. D.

1362. *Sun's Temperature.* **E. Warburg.** (Verh. Deutsch. Phys. Gesell. 1. pp. 50–52, 1899.)—If a hemispherical surface at t° C. radiates H_t calories per second to a perfectly black area of 1 sq. cm. at 0° C. at the centre of its circular base, the latter will gain $k(H_t-H_0)=s$ cal. per sec. from a part of the hemisphere of angular diameter ϕ. The gain $H_{100}-H_0=h$, may be experimentally found, and the assumption of Stefan's law $H_x/H_0=(1+x/273)^4$ then gives

$$t=273\sqrt[4]{[\{(373/273)^4-1\}\, s/h\,k+1]}-273.$$

Applying this formula to the sun, for which $\phi=0^\circ\ 32'$, and taking for h Kurlbaum's value 0·0176, and for s a value between $\frac{1}{20}$ (Langley's) and $\frac{1}{15}$ (Ångström's), the author finds 6490° C. for the temperature of the sun.

[But he takes $\sin^2\frac{1}{2}\phi$ for k instead of $2\sin^2\frac{1}{4}\phi$, which correction would raise his estimate to 7770° C. The temperature of the firmament, which he calls 0°, is meant to be 0° abs.] R. E. B.

1363. *Dulong and Petit's Law.* **F. Richarz.** (Verh. Deutsch. Phys. Gesell. 1. pp. 47–48, 1899.)—The author has previously shown that in the case of a monatomic gas, such as mercury, the specific heat at constant volume is half the specific heat of the element in the solid state, and it is now pointed out that this relation affords a means of calculating the atomic heat of the solid elements, *i.e.*, the constant in Dulong and Petit's law. The difference between the two specific heats is $C_p-C_v=0{\cdot}0691/d$, where

d is the sp. gr. of the gas compared with air, and since $C_p/C_v = 5/3$ for a monatomic gas, we have $C_v = 3 \times 0.0691/2d$. But if A is the atomic weight of the gas, $d = A/2 \times 14{\cdot}5$, where 14·5 is the sp. gr. of air compared with hydrogen; hence $AC_v = 3 \times 0{\cdot}0691 \times 14{\cdot}5 = 3{\cdot}006$, the atomic heat of the gas. The atomic heat of the solid element is therefore twice this, or 6·012; but since the specific heats of solids are determined at constant pressure, a slight correction has still to be applied, and the atomic heats of the metals silver, iron, copper, platinum, gold, aluminium, lead, and zinc are thus found to lie between 6·072 and 6·252. N. L.

1364. *Kinetic Theory of Liquids.* **G. Jäger.** (Wied. Annalen, 67. 4. pp. 894–898, 1899.)—The author claims that in all his mathematical papers on the kinetic theory of liquids he avoided coming into conflict with the most salient facts of experimental knowledge. In all kinetic theories certain inaccuracies must necessarily occur, as they do even in the simple relation between the pressure and the volume of a gas. But useful mathematical results may be attained by treating of those elements which have the most essential influence upon the phenomena in question. Voigt's applications of Boyle's law and the law of gaseous friction to liquids leads to results in contradiction with experimental data. E. E. F.

1365. *Kinetic Theory of Liquids.* **W. Voigt.** (Wied. Annalen, 68. 1. pp. 139–142. 1899.)—The author replies to Jäger's criticism of certain details in his application of Van der Waals' theory to liquids. E. E. F.

1366. *Mechanical Equivalent of Heat.* **C. W. Waidner** and **F. Mallory.** (Phys. Rev. 8. pp. 193–236, 1899.)—Recent determinations of the mechanical equivalent of heat by electrical methods have given results differing from those obtained by mechanical means by amounts greater than the probable experimental errors. One object of the present paper is to compare Rowland's results with those obtained by Griffiths, and by Schuster and Gannon.

The thermometers used by Rowland are compared with a platinum thermometer made under the supervision of Griffiths. The latter is also compared with a Tonnelot thermometer, of which an exhaustive study was made by Guillaume some years ago, and from which readings on the nitrogen scale can be obtained. Thus Rowland's readings and the readings of a thermometer of the type used by Griffiths can be brought to the same nitrogen scale.

The electrical methods depend for their accuracy on the knowledge of the E.M.F. of a Clark cell, for which Kahle's latest results give the value 1·4325 volts at 15°. The ultimate conclusions are shown in the following table, the fourth column referring to the nitrogen scale, and being based on the assumption that the E.M.F. of a Clark cell is that already mentioned:—

		Old.	Corrected.
At 15°	Rowland (air scale)......	$4{\cdot}189 \times 10^7$	$4{\cdot}187 \times 10^7$
	Griffiths (N. scale)	$4{\cdot}198 \times 10^7$	$4{\cdot}190 \times 10^7$
At 20°	Rowland	$4{\cdot}179 \times 10^7$	$4{\cdot}181 \times 10^7$
	Griffiths	$4{\cdot}192 \times 10^7$	$4{\cdot}184 \times 10^7$
	Schuster & Gannon (N. scale) at 19° 1.........	$4{\cdot}1905 \times 10^7$	$4{\cdot}185 \times 10^7$
At 25°	Rowland	$4{\cdot}173 \times 10^7$	$4{\cdot}176 \times 10^7$
	Griffiths	$4{\cdot}187 \times 10^7$	$4{\cdot}179 \times 10^7$

A. Gs.

1367. *Model of Carnot's Engine.* **J. C. Shedd.** (Phys. Rev. 8. pp. 174–180, 1899.)—The author describes a simple model for illustrating the successive operations of the Carnot cycle, and the reversibility, efficiency, &c., of the engine.

W. R. C.

SOUND.

1368. *Pitches of Appunn Pipes.* **F. A. Schulze.** (Wied. Annalen, 68. 1. pp. 99–104, 1899.)—A set of Appunn pipes marked c^5, c^6, c^7, c^8, and c^9 are tested with regard to their pitches by a revolving mirror method (with photographic records), by Kundt's dust figures, and by Quincke's interference method. All these methods gave concordant results, and showed that Appunn's calculated values were not correct. Thus the pipe marked c^9, whose pitch should be 56,800 vibrations per second, actually has a frequency of 10,300, and should therefore be marked fes^6. E. E. F.

1369. *Determination of Pitches.* **C. Stumpf.** (Wied. Annalen, 68. 1. pp. 105–116, 1899.)—In reply to Appunn's criticism of the value of the difference tone method for determining high pitches, the author shows that this method is both convenient and reliable. The discrimination between difference tones of the first order and those of higher orders is not difficult. As long as the primary notes lie within the same octave, there are only two difference tones below the primary notes. The one represents the difference between the two notes sounding together, while the other represents the difference between the higher note and the octave of the lower one. These are distinguished by the fact that as the higher note ascends, the pitch of the first difference tone rises, while that of the second one falls. When the pitches of two high notes to be compared vary very widely, errors are easily made, but these can be eliminated by the use of intermediate pipes. The author believes that the difference tone method is, for the practised ear, the most rapid and accurate for the determination of high pitches. His measurements are confirmed by the objective methods used by Schulze. E. E. F.

1370. *Conical and Irregular Organ Pipes.* **Neyreneuf.** (Annal. Chim. Phys. 16. pp. 562–574, 1899.)—The author tests the influence of a conical addition to a cylindrical pipe upon the note which it emits, or to which it resounds. He finds that if a wider cone is added, the length has as a rule to be increased to produce resonance to the same note, and if a narrower cone is added the length has to be diminished. The nodes are always in the same plane A B, and a maximum or a minimum respectively is attained when the joint between cone and cylinder lies in this plane. E. E. F.

1371. *Cooling of Air and Propagation of Sound.* **Rayleigh.** (Phil. Mag. 47. pp. 308–314, 1899.)—A discussion of the radiating power of air, from which it appears that the cooling of moderate masses of air is not sensibly influenced by radiation. This result deduced from theory is confirmed by experiments on the lines of those of Clément and Desormes, which indicate that the observed cooling (or heating) which occurs can be adequately explained by the conduction of heat from the walls of the vessel, in accordance with the known conductivity of air. In many actual observations on sound the intensity does not fall off in accordance with the law of inverse squares of distances. The author attributes these discrepancies to atmospheric refraction and reflection, and thinks that Mr. Wilmer Duff's explanation (Phys. Rev. vi. 1898) of the attentuation noted in his observations, viz. radiation, is not the true one. J. J. S.

1372. *Radiophone.* (Scientific American, 80. p. 347, 1899.)—An arc lamp is supplied with current, and when the arc is formed a microphone is connected as a shunt to the two carbons through a resistance. The light from the arc is reflected by a parabolic mirror towards a conjugate mirror, at the focus of which is a glass bulb-tube containing granulated carbon. The bulb-tube is connected by an indiarubber tube to an ear-piece. A cornet playing "in front of the transmitter" was heard in the receiver at a distance of 350 feet. [It is not stated whether the effect is as great with the cornet placed behind the transmitter.] R. A.

ELECTRICITY.

1373. *Electrostatic Theorems.* **P. Saurel.** (Journ. Phys. Chem. 3 pp. 232–233, 1899.)—Denoting the electrical energy of a system of electrified points by W, we have—

$$W = \Sigma \frac{q_m q_n}{r_{mn}} = \tfrac{1}{2} \Sigma V_m q_m,$$

q_m, q_n being the charges at the points m, n; r_{mn} the distance between these points; and V_m the potential at the point m.

From this—

$$dW = \tfrac{1}{2} \Sigma V_m dq_m + \tfrac{1}{2} \Sigma q_m dV_m \qquad (1)$$

Considering the work dT done by a small displacement we have—

$$dT = \Sigma \frac{q_m q_n}{r^2_{mn}} dr_{mn} = -\Sigma q_m q_n d\frac{1}{r_{mn}}$$

$$= -d\Sigma \frac{q_m q_n}{r_{mn}} + \Sigma \frac{q_m dq_n + q_n dq_m}{r_{mn}}$$

$$= -dW + \Sigma V_m dq_m \qquad (2)$$

By (1) this becomes—

$$dT = dW - \Sigma q_m dV_m ; \qquad (3)$$

and on adding (2) and (3) we get—

$$dT = \tfrac{1}{2} \Sigma V_m dq_m - \tfrac{1}{2} \Sigma q_m dV_m \qquad (4)$$

There are three cases of interest:—

(1) $dV_m = 0$; when $dT = dW$ (Maxwell's theorem),

(2) $dq_m = 0$; when $dT = -dW$, and

(3) $dT = 0$; in which case $dW = \Sigma V_m dq_m = \Sigma q_m dV_m$.

E. H. B.

1374. *The KR Law.* **W. Moon.** (Elect. Rev. 44. pp. 352–353, 1899.)—The law of current propagation in wires having K capacity and ρ resistance per unit length is $\frac{d^2v}{dx^2} = K\rho \frac{dv}{dt}$ (Fourier).

Blakesley's formula for the general solution for alternating currents is compared to the KR law. Incidentally Blakesley's formula is criticised as leading to $2\sqrt{\frac{\pi}{K\rho r}}$ for the wave velocity of electricity, whereas the wave velocity should be less than that of electricity, just as the velocity of electricity is probably less than that of electromagnetic induction. The Kelvin formula gives $\frac{D}{d}=1{\cdot}65$ for the best ratio of diameters over the dielectric and over the copper. Blakesley's formula does not, and in this respect the Kelvin formula is probably wrong. M. O'G.

1375. *Loss of Electric Charge by Evaporation.* **H. Pellat.** (Écl. Électr. 18. pp. 481–487, 1899.)—The author gives an account of experiments referred to in Abstract No. 562 (1899). Although the experiments establish the fact that the vapour of an electrified liquid carries off its charge, they equally show that *no electrification of an uncharged liquid can occur by evaporation*—a conclusion contrary to the assumptions made by certain meteorologists. The paper concludes with a discussion of the bearing of the author's experiments on certain known meteorological facts. A. H.

1376. *Leakage of Electricity from Charged Bodies.* **J. C. Beattie.** (Phil. Mag. 48. pp. 97–106, July, 1899.)—This paper is one of a series giving the results obtained on the leakage of electricity from metallic plates covered with various substances when the plates were placed in an atmosphere whose temperature was gradually raised from that of the room up to 250° or 300° C. In the present paper only those experiments are described in which a potential difference of between 80 and 240 volts was used. E. H. B.

1377. *Constitution of the Electric Spark.* **A. Schuster** and **G. Hemsalech.** (Roy. Soc. Proc. 64. pp. 331–336, 1899.)—When a spark passes between metallic electrodes, the spectrum of the metal appears not only in contact with the electrodes but often stretches from pole to pole. It follows that during the spark-interval the metallic vapours must be able to diffuse through measurable distances. An image of the spark is projected on the slit of a spectroscope, and photographs are taken on a film fixed round the rim of a rotating wheel (Dixon's method). The metallic lines are inclined and curved when the wheel rotates, and their inclination serves to measure the rate of diffusion of the metallic particles. The air lines remain straight although slightly widened. Comparing different metals with each other, it is found that those having comparatively low atomic weights, viz., aluminium and magnesium, have high molecular velocities. The average velocity of the aluminium molecule was found to be over three times as great as that of zinc. Cadmium and zinc gave almost identical numbers. Bismuth gave remarkable results. In spite of its high atomic weight some of the lines are but little displaced, indicating an average molecular velocity of 1,420 metres per second.

The authors are of opinion that the initial discharge takes place through the air: it must do so, because at first no metallic vapour is present. The intense heat generated by the current volatilises the metal, which then begins to diffuse away from the poles. The subsequent oscillations of the discharge take place through the metallic vapours, and not through the air. When the spark is directly focussed on the sensitive film (without interposition of the prism) the photographs show a straight image of the slit followed by a number of curved bands extending from both poles into the spark-gap. The straight image is considered to be the initial discharge through air creating sufficient heat to fill the space with vapour through which the oscillating discharges may then pass. D. E. J.

1378. *Spark Discharge in Solid and Liquid Dielectrics.* **J. Almy.** (Verh. Deutsch. Phys. Gesell. 1. pp. 95–99, 1899.)—The apparatus used in experimenting on solid dielectrics consisted of a spherical metallic electrode 1 cm. in radius, cemented into a vertical glass tube in such a manner that the plane through the ground end of the tube was tangential to the sphere. The end of the tube having been covered with a thin film of oil, the sheet of dielectric to be experimented upon was laid on the end of the tube, and on the top of it was placed a small metal cylinder, which formed the other electrode. The electrodes of this apparatus were connected to an electrometer and an influence machine which was driven by an electromotor. The potential of the insulated electrode was raised slowly by adjusting a point-discharge shunt until a spark pierced the dielectric. The following results were obtained: 1. The discharge potential is about 5 per cent. less when the spherical electrode is replaced by a pointed one. 2. With dissimilar electrodes the discharge potential is but little affected by reversal of polarity. 3. Considerably lower values of the discharge potential are obtained if, instead of raising the potential gradually, oscillations are allowed to take place by connecting an air spark-gap in parallel with the apparatus, and increasing the gap until the dielectric is pierced. 4. The relation between the discharge potential V and the thickness d of the dielectric may be expressed by a linear equation of the form $V = \alpha d + \beta$, where α and β are two constants, the values of which for certain specimens of glass, mica, and paraffin were found to be as follows:

Substance.	α.	β.	Limits of Sparking Distance.
Glass	420	41·5	·04 to ·225 cm.
Mica	18,800	10	·003 to ·006 „
Paraffin wax	3,560	17·2	·015 to ·036 „

The above values of the constants give the discharge potential in electrostatic C.G.S. units. 5. In the case of three different specimens of glass and plates of quartz cut parallel and normal to the axis of the crystal, it was found that the order of dielectric strength is the same as that of resistivity.

In the experiments with liquid dielectrics two spherical electrodes, each 2 cms. in diameter, were used. Special precautions were adopted to free the liquid under investigation from foreign solid particles. For this purpose the liquid was filtered under atmospheric pressure through a porous earthenware cylinder into the discharge vessel, which was connected with an air-pump. Further, the liquid was filtered and the electrodes freshly polished after the passage of every spark, as the dielectric strength was found to be seriously impaired (on account of the production of solid particles) by even a single spark, as the following results obtained with xylol (the sparking distance being ·04 cm.) show:—

Conditions of Experiment.	Discharge Potential in Electrostatic Units.
Ordinary clean xylol in open vessel	10–25
Xylol filtered through silk, in open vessel	25–40
Xylol filtered through earthenware cylinder, in closed vessel, and after passage of one spark	55–70
Xylol, before passage of spark, electrodes not freshly polished	80–85
Xylol, before passage of spark, electrodes newly polished	91–93

As is the case with solid dielectrics, a linear relation connects discharge potential with sparking distance, the values of α and β for some liquids being given in the following table:—

Liquid.	α.	β.	Limits of Sparking Distance.
Xylol	1340	40	·01 –·067 cm.
Oil of turpentine	1410	20	·02 –·08 „
Petroleum	1920	20·2	·018–·06 „
Benzene	1750	21·1	·04 –·055 „

These values for the sparking potential are much higher (being in some cases five to eight times as great) than those obtained by Edmondson (see 1898, Abstract No. 923), who, however, did not take sufficient precautions to eliminate solid particles from the liquid. A. H.

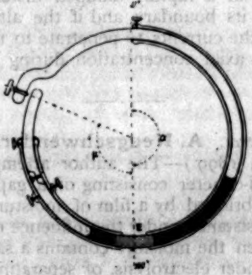
1379. *Criterion for Oscillatory Discharge of a Condenser.* **E. H. Barton** and **W. B. Morton.** (Phil. Mag. 48. pp. 143–150, July, 1899.)—In the ordinary theory of condenser discharges it is assumed that the resistance and inductance of the circuit have definite constant values equal to those corresponding to steady currents. The condition for an oscillatory discharge ($C<4L/R^2$) is modified when we take into consideration the fact that with damped oscillations the current is not uniformly distributed over the cross-section of the conductor. The authors' investigation shows that when this latter fact is taken into account, the critical capacity on the simple theory ($C=4L/R^2$) corresponds in reality to an *oscillating* discharge. This result is contrary to what one would at first sight expect, since it is known that the resistance of a wire is greater, and its inductance less, for alternating than for continuous currents. The explanation of the apparent paradox is to be found in the effect of the *damping* on the *inductance*. The authors show that when the damping becomes great the value of the equivalent inductance is greater than its value for steady currents, there being an *axis*-concentration of the current in the conductor, instead of the usual surface-concentration with undamped oscillations. In this connection the authors remark that from general reasoning it seems clear that, if we think of a rapidly damped disturbance propagated into a wire from its boundary, and if the alternations are slow enough to allow the currents to penetrate to the core, we should expect to find an axial concentration during the latter stages of the phenomenon. A. H.

1380. *Anti-coherer*. **A. Neugschwender.** (Wied. Annalen, 68. 1. pp. 92–98, 1899.)—The author attempts to explain the action of the anti-coherer consisting of a gap between metallic deposits on glass bridged by a film of moisture. He finds that the increase of resistance under the influence of electric waves is only observed when the moisture contains a salt, and when that salt is capable, under electrolysis, of separating out pure metal. On sending a current through a gap in a platinum deposit bridged by a drop of silver nitrate solution, minute tree-like structures are seen under the microscope to form at the kathode. These gradually extend across towards the anode, thereby considerably diminishing the resistance encountered by the current. When electric waves impinge upon the gap, sparks proceed from the ends of the branches, and the trees are broken up into small pieces, which appear considerably agitated. On the cessation of the waves the pieces cohere again more or less, and the original conductivity is partially restored. Hence the "self-righting" action observed. The resistance may thus vary between 50 and 90,000 ohms. E. E. F.

1381. *Propagation of Long Electrical Waves*. **M. I. Pupin.** (Amer. Instit. Elect. Engin. 16, pp. 111–160, 1899.)—This paper describes an experimental method of investigating the propagation of long electrical waves, and discusses the mathematical theory bearing upon the same. The theory deals with the following

questions: (1) What variation does the wave energy undergo during its propagation from the transmitting to the receiving apparatus? and (2) What are the means theoretically suggested for measuring the wave-length and the velocity of propagation of the long electrical waves which accompany forced electrical oscillations? In the experiments the electric waves of a frequency of about 1,000 per second were sent along conductors having capacity and inductance so arranged as to represent in the space of the laboratory some miles of a telephone circuit.
E. H. B.

1382. *Resonator with Gap.* **A. Turpain.** (Écl. Électr. 18. pp. 312–313, 1899.)—The author modifies the Hertzian ring resonator by making an ebonite gap at E, and clamping the two portions of the ring in copper tubes, so that the azimuth μ of the spark with respect to the gap may be adjusted within wide limits.



When the position of the ring is adjusted for maximum spark length, that maximum steadily diminishes from 350 to 100 microns as the angle μ is diminished from 180° to 50°. (See also 1898, Abstract No. 512.)
E. E. F.

1383. *High-Frequency Experiments.* **N. Tesla.** (Elect. Rev. N.Y. 34. pp. 193–197 and 204, 1899.)—A popular illustrated account of the author's high-frequency experiments, using vibrations of from 400,000 to 800,000 per second.
W. R. C.

1384. *Hall Effect in a Binary Electrolyte.* **F. G. Donnan.** (Phil. Mag. 46. pp. 465–472, 1898.)—A calculation showing that the potential-gradient of the Hall effect must bear to the potential-gradient of the primary current a ratio of the order of $16 \times 10^{-13} : 1$, and is therefore very easily missed.
A. D.

1385. *Contact and E.M.F.* **Q. Majorana.** (Roma R. Accad. Lincei Atti, 8. pp. 255–259 and 302–309, 1899.)—Description of a modified Thomson replenisher, in a simple and a more complex form, the effect of which is to produce a current off a commutator. Calculation as to the approximate E.M.F. required to generate this current. Experiments as to the actual attraction between opposite charges induced by contact E.M.F., and the values calculated for this. A. D.

1386. *Self-Induction Experiments.* **A. G. Dell.** (Elect. Rev. N.Y. 34. p. 207, 1899.)—A self-induction, a voltaic cell (as free from polarisation as possible), a coherer, and a galvanometer are connected in series in the order mentioned so as to form a closed circuit. A key is connected up from a point between the cell and coherer to a point between the self-induction and the galvanometer. On depressing the key so as to close this second circuit, the galvanometer needle is not deflected; but upon breaking this circuit a deflection occurs which depends upon the value of the self-induction. W. G. R.

1387. *Conductivity of Copper in Various Dielectrics.* **J. F. Merrill.** (Phys. Rev. 8. pp. 112–127, 1899.)—The resistances of two similar spirals of copper wire are compared when both spirals are in air and again when one is in air and the other in another dielectric. Platinum thermometers give the mean temperatures of the spirals, and any variations of resistance due to temperature are allowed for. The method used is a very sensitive Wheatstone's bridge arrangement, the two spirals forming two of the arms of the bridge, and a balance being produced by shunting one of the spirals by a variable resistance. All the necessary precautions are taken. The dielectrics used are kerosene, absolute alcohol (both as vapour and as liquid), ether vapour, gasoline, benzene (liquid and vapour), petrolic ether, and chloroform vapour. All the variations noticed were within the limits of experimental error, the maximum being 0·008 per cent. Previous results of Sanford and Grimaldi and Platania are criticised. J. B. H.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1388. *Explosions Caused by Commonly Occurring Substances.* **C. E. Munroe.** (Science, 9. pp. 345–363, 1899.)—Presidential address to the American Chemical Society. Gives an account of explosions caused by flour dust, zinc dust, by various compounds used in chemical laboratories, by paraffines, benzoline, naphtha, "driers," and by fire-damp in mines. D. E. J.

1389. *Endothermic Gases.* **W. G. Mixter.** (Amer. Journ. Sci. 7. pp. 323–327, 1899.)—A spark or a red-hot platinum wire explodes acetylene gas if at 3 or more atmospheres but not at 2 atmos. pressure. The weak glow discharge does not cause explosion up to 20 atmos. pressure. Admixture of hydrogen prevents explosion to some extent. Partially liquefied cyanogen at about 5 atmos. pressure is not exploded by sparks or by a platinum wire heated to its melting-point. A filament of carbon forms between the wires between which the sparks are passed. Nitrous and nitric oxides are slowly decomposed when sparked under pressure, but do not explode. T. E.

1390. *Non-Explosive Combination of Explosive Gases.* **W. G. Mixter.** (Amer. Journ. Sci. 7. pp. 327–334, 1899.)—Detonating gas, mixtures of carbonic oxide or cyanogen with oxygen, and other explosive mixtures of gases, do not explode when sparked below a certain pressure. A similar statement applies to the explosive decomposition of acetylene. The author concludes that the explosions do not occur in the instances given, because of the infrequency of impacts of molecules having a velocity or internal energy adequate for chemical union. [Van't Hoff gave an adequate discussion of this matter in the Études de Dynamique Chimique, in 1885.] T. E.

1391. *Composition of Mixed Vapours.* **H. R. Carveth.** (Journ. Phys. Chem. 3. pp. 193–213, 1899.)—In order to determine the composition of the vapour evolved by a boiling mixture of two volatile liquids, the mixture is placed in a large flask closed by a cork, through which a glass tube, blown out at its lower end to a small pear-shaped bulb, is passed. The upper part of the small bulb is perforated by several holes, and a platinum wire is sealed through its lower extremity as in Beckmann's apparatus for the determination of boiling-points. A condenser passes through the cork of the large flask, arranged so that the condensed liquid may flow back into the main body of the solution, or into the small flask through one of the abovementioned perforations. Both the small and the large flask contain thermometers. When the perforations of the small flask dip below the surface of the solution, both thermometers indicate the same temperature, *i.e.*, the boiling-point of the solution. When the small flask is raised, so that it only touches the solution, and the condensed vapour is allowed to flow into it, this condensed vapour is soon raised to its boiling-point (which is always lower than that of the less volatile, original solution). One thermometer now indicates the boiling-point of the original solution, the other that of the condensed vapour. By taking the quantity of solution large in comparison with the quantity of condensed vapour, the concentration of the former is but little affected by the removal of the latter. When a number of determinations have been made with solutions of known concentration, a curve may be drawn from which the unknown concentration of the condensed vapour may be obtained from its boiling-point. The composition of the vapour evolved from mixtures of carbon bisulphide and benzene is determined by distillation experiments, and the results compared with those obtained by the method just described. In this way an error was discovered, due to the hot vapours from the boiling liquid carrying away some of the more volatile constituent of the liquid returning from the condenser. By modifying the apparatus slightly this was prevented, and results in good agreement with the distillation experiments obtained. T. E.

1392. *Continuous Transition between Solid and Liquid.* **G. A. Hulett.** (Zeitschr. Phys. Chem. 28. pp. 629–672, 1899.)—Some substances such as p-azoxyanisol, p-azoxyphenetol, and cholesteryl benzoate were found by Lehmann to exhibit a curious transition, being transformed, namely, at a certain temperature peculiar to each substance, into liquid phases which still possess crystalline properties. The author investigates the effect of pressure on this transition-point, up to 300 atmospheres. The transition-temperature is found to rise considerably with pressure in all three cases. The heats of transformation at various pressures are calculated by making parallel experiments with solutions of thymol in the aforementioned substances, and applying van't Hoff's formula to the depressions of the transition-points. These values do not agree with the values calculated by means of the Thomson-Clausius formula from Schenck's observations on the volume-changes involved, which discrepancy is shown by the author to be due to the fact that the thymol dissolves in the liquid crystals, so that the original van't Hoff formula is not applicable.

The author measures further the effect of pressure on the transition-temperature of solid-liquid crystals, and is able here to apply the van't Hoff formula, after making parallel experiments with thymol solutions and observing the corresponding depressions. In the case of p-azoxyanisol and p-azoxyphenetol the heat of transformation is found to *increase* with the temperature, indicating a solid-liquid critical point at *negative* pressures.

Similar experiments were made with benzene, p-toluidine, and camphor, where, of course, the liquid phase possesses no crystalline properties. In conclusion the author points out the possibility of the existence of a solid-liquid critical point at *negative* as well as *positive* pressures.

In an appendix are contained similar pressure-temperature determinations for Phenol, Thymol, Naphthalene, Naphtylamine, Benzophenone, Stearic Acid, Crotonic Acid, Nitrophenol, Phosphorus, Menthol, and Monochloracetic Acid. F. G. D.

1393. *Velocity of Crystallisation.* **M. Wilderman.** (Proc. Chem. Soc. 15. p. 175, 1899.)—The rise of temperature accompanying the separation of ice or a salt from supercooled or supersaturated solutions is measured by means of a platinum thermometer, arranged to give a continuous record on a rotating drum. The results may be expressed in the form of an equation, viz., $dt/dz = C\,(t_0 - t)\,(t - t_1 + K)$, where t_0 is the temperature of equilibrium and t_1 the temperature at which the reaction began, and C and K are constants, and z the time. T. E.

1394. *Röntgen Ray Photography and Alloys.* **C. T. Heycock** and **F. H. Neville.** (Journ. Chem. Soc. 73. pp. 714–723, 1898.)—Freezing a dilute solution of permanganate of potash, we have first clear ice crystals, and then solidification of the permanganate with the water. Starting with a hot concentrated solution, crystals of permanganate are first formed, and then the same ice-permanganate solid as in the previous case. A solution can be made, of intermediate strength, which will freeze homogeneously. It is saturated at its freezing-point. With alloys, slow cooling results in crystals or threads, &c., which can be rendered visible by radiographing very thin sections. A series of interesting radiographs accompanies the paper and shows the structure and the variations of this with modes of cooling in alloys of different composition. A. D.

1395. *Metallography.* **E. Heyn.** (Frank. Instit. Journ. 147. pp. 447–463, June, 1899.)—The contribution of Heyn to this subject is translated by Kreuzpointner, and is illustrated by a large number of photographs of etched surfaces of bronze and steel.

Heyn asserts that the micro-structure of a metal or alloy is dependent only upon the temperature and mechanical treatment to which it has been subjected, but not upon time of etching, as asserted by Outerbridge and Clamer. The reagents used for etching, and the time of such treatment bring into view *different details of the micro-structure*, but they cannot possibly be held to alter the latter. Heyn supports this assertion by details of the examination of a machinery bronze and of a soft steel; the variations in the micro-graphic structure of each of which are shown by the aid of the photographs to be apparent, but not real.

These apparent changes of structure are also shown to be caused at times by variations in the method of photographing the etched surface. They may also be due to variations in the etching power of the reagent used, owing to accumulation of salts of iron in the fluid, at points upon the surface of the metal or alloy. The paper closes with some remarks upon the selection of sections from plates and bars, for submission to the micrographic examination.

Notes are added by Kreuzpointner, Sauveur, and Outerbridge, relating chiefly to the previous contribution by Outerbridge, which called forth Heyn's reply. Kreutzpointner and Outerbridge still contend that the introduction of standard methods in metallography is required before the science can become of practical service in foundries and engineering shops.

J. B. C. K.

1396. *Thermal Effects of Dilution.* **J. H. Pollok.** (Proc. Chem. Soc. 18. pp. 8–9, 1899.)—The author has mixed saturated solutions of various salts with equal volumes of water at the same temperature and found that the temperature sometimes rises, sometimes falls. Seventeen salts are examined, and the changes of temperature, varying from +0·6° for $CaCl_2$ to −1·8° for $NaNO_3$, are given.

T. E.

1397. *Iodine Compounds.* **E. C. Sullivan.** (Zeitschr. Phys. Chem. 28. pp. 523–545, 1899.)—The properties of iodine in iodonium bases, which are shown by conductivity and velocity of saponification to be strong bases, ionised to (nearly) the same extent as soda, differ from those in other compounds. The constants of refractive power of iodine are as follows:—

	$R_{D.}$	$R^2_{D.}$
In iodides (as ion)	28·3	16·6
,, iodobenzene	25·9	14·1
,, diphenyliodonium	27·9	17·1
,, iodobenzene chloride ...	36·8	18·7

In iodates R is probably less than 22·9. The electric potential of iodobenzene chloride is somewhat less than that of free chlorine; the latter varies with the concentration (in HCl solution) according to Henry's law, whence the molecule is Cl_2. Iodine chloride shows the same potential alone as when mixed or combined with rubidium chloride, hence the same active constituent is shown to exist: the reduction is a univalent reaction; in solution in HCl complex molecules are probably formed, as the depression of the freezing-point and the increase in conductivity are both smaller than if the ICl were hydrolysed to HIO_3 and HCl: iodine is observed to be set free. B. B. T.

1398. *Hydrolytic Dissociation and Thermochemistry.* **G. Platner.** (Elektrochem. Ztschr. 5. pp. 229–232 and p. 247, 1899.)—The figures for the heat of formation, derived from the elements and water, show, according to Platner, no connection with the figures calculated from hydroxide, acid, and neutralisation; but they are in close agreement when we take the hydrolytic dissociation into consideration. In the first paper, the author points out that the nitrates offer particularly instructive examples, inasmuch as the heat of formation of nitric acid is exactly equal to the heat of decomposition of water, so that the two terms eliminate one another. The second paper admits that these two terms differ by 29·84 cal. (98·2 − 68·36); but their difference proves constant for the nitrates of Ag, K, Na, Ba, Mg, Zn, Cd, Cu. The hydrolytic dissociation fails, however, in the case of cyanides. The experiments concern the redetermination of the heat of solution of 25 salts, mostly chlorides, also nitrates, sulphates, &c. H. B.

1399. *Optically Active Alkyloxypropionic Acids.* **T. Purdie** and **G. D. Lander.** (Journ. Chem. Soc. 73. pp. 862–878, 1898.)—A very great increase in optical activity attends the replacement of the alcoholic hydrogen of lactic acid by an alkyl group; and the greater the weight of the introduced alkyl group the greater is this increase. The increase of optical activity upon dilution is in some cases very great. A. D.

1400. *Optical Activity of Gallotannic Acid.* **O. Rosenheim** and **P. Schidrowitz.** (Journ. Chem. Soc. 73. pp. 878–893, 1898.)—Commercial, so-called pure, gallotannic acid contains varying quantities of gallic acid and of mineral substances, to which latter the great differences in optical activity, ranging from $[\alpha]_D + 11^\circ$ to $[\alpha]_D + 74^\circ.2$, are probably due. The chief constituent is a substance of $[\alpha]_D + 75$. The optical activity slightly increases with dilution down to 1 per cent. and then remains steady; varies greatly with the solvent employed; and is greatly affected by inactive substances, being depressed by alkalis and by mineral salts. The chemical formula for gallotannic acid, which contains no asymmetrical carbon atom, would appear to be wrong. A. D.

1401. *Rotatory Power of Sugar.* **E. Mascart** and **H. Bénard.** (Annal. Chim. Phys. 17. pp. 125–144, 1899.)—At the request of a commission nominated by the French Minister of Finance the authors have redetermined the concentration of the normal sugar solution employed in saccharimetry. This quantity is the weight of pure sugar contained in 100 cc. of a solution which gives a rotation of 21·67 in a tube 20 cm. long at 20° C., the light employed being that of a sodium flame. The observations are made with instruments of the Laurent type. When the light is filtered through a plate of potassium bichromate the rotations observed are about 0·1 per cent. too small; the addition of a plate of nickel sulphate, however, gives sufficiently homogeneous light. The influence of temperature on the results is carefully examined. The final result is that, at 20°, in solutions containing about 16 grammes per 100 cc., the specific rotation of sugar $[\alpha]^{D}_{20^\circ} = 66{\cdot}54$, and that the normal solution above defined contains 16·284 grammes.

If, in determining the volume of the measuring flask employed in making up the solutions and in weighing the sugar, the weighings are not reduced to *vacuo*, the weight of sugar which must be taken becomes 16·29 grammes. T. E.

1402. *Mixtures of Optical Isomers.* **G. Bruni.** (Roma R. Accad. Lincei Atti, 8. pp. 332–335, 1899.)—Bakkuis-Roozeboom (Berl. Berichte, xxxii. 537) applies solubilities and fusing-points to the determination of the question whether a given mixture of optical isomers contains true racemic compounds, inactive conglomerates, or mixed pseudo-racemic crystals. The author applies cryohydrate phenomena to the same purpose. A. D.

1403. *Ternary Mixtures, IV.* **W. D. Bancroft.** (Journ. Phys. Chem. 3. pp. 217–231, 1899.)—The results of the experiments of Wright, both by himself and in collaboration with Thompson and Leon, on the solutions of a metal, C, in two partially miscible metals, A and B, which are in equilibrium at a given temperature, are here examined. Now if A and B are non-miscible, and C_1, C_2 represent the amounts of the solute C in two phases in equilibrium which contain respectively A_1 and B_2 of the solvents A and B, Taylor has shown that normally

$$(C_1/A_1)^m \div (C_2/B_2)^n = K,$$

where m, n, K are constants. The author tests the applicability of this formula to the cases under review by plotting the logarithms of the concentrations C_1/A_1 and C_2/A_2, measured in grammes, per 100 grammes of the alloy, as ordinates and abscissæ respectively, the subscript 1 referring to the denser phase, and finds the loci obtained to be fairly linear (justifying the formula) along the greater part of their stretch, though curved for the smallest values of the concentration in the first metal for the systems 6–9 below and also for the largest values of this concentration for the system 9. His results are tabulated below, the values given for K being the means obtained from the author's figures for the approximately linear parts of the stretches.

	A	C	B	Temp. C.	*m*	*n*	K
1	Pb	Ag	Zn	750–850	−1·	−1·8	38·9
2	Bi	Sn	Zn	650	1·	1·25	4·30
3	Bi	Cd	Zn	600	1·	0·96	1·76
4	Cd	Sn	Al	700–750	0·92	1·	2·23
5	Bi	Sn	Al	750–850	1·	1·05	1·57
6	Pb	Ag	Al	830–900	−1·	−1·65	242·
7	Bi	Ag	Al	830–900	−1·	−1·43	73·4
8	Bi	Ag	Zn	700–800	−1·	−3·8	10·9
9	Pb	Sn	Al	750–850	1·	1·85	1·24

The curving may be due to experimental error and also to neglect of the effect of the mutual miscibility of the solvent liquids.

It is further found that, with the exception of Cd or Sb in Zn and Pb, the distribution-ratio C_1/C_2, or C_2/C_1, does not exceed 2 for any system not containing Ag; and also that the distribution-ratio for dilute solutions stands in no obvious relation to the reacting weights of the partially miscible metals. R. E. B.

1404. *New Class of Inorganic Acids.* **W. Hittorf and H. Salkowski.** (Zeitschr. Phys. Chem. 28. pp. 546–555, 1899.)—The compound $PtCl_4 + 5H_2O$, shown by Jörgensen to be a dibasic acid forming the insoluble salt $Ag_2PtCl_4.O + H_2O$, and by Kohlrausch to conduct well, is investigated in respect to transference. The Pt and Cl migrate together towards the anode, transference value about 0·13. Gold chloride forms a similar acid, H_2AuCl_3O, transference value 0·23. It is suggested that other acids of this class may be discovered. B. B. T.

1405. *Electrolysis of Mixed Electrolytes with a Common Ion.* **J. G. MacGregor.** (Phys. Rev. 8. pp. 129–140, 1899.)—Schrader, Hopfgartner, and Hoffmeister have electrolysed aqueous solutions containing two electrolytes having a common ion, the object being to determine the effect produced on the ionisation of an electrolyte by the addition of a second. The effect produced was, in some cases, of the kind required by the ionisation theory. The theory may be more satisfactorily tested by determining the ionisation coefficients in the complex solutions, then calculating the relative amounts of the distinctive ions transferred by the current, and comparing these values with those found by experiment. This the author has done, making use of the experimental work of the above observers. The results are reasonably satisfactory for solutions of $NaCl+HCl$, $KI+KCl$, and $BaCl_2+HCl$. In the case of $H_2SO_4+CuSO_4$, the calculated values differ considerably from those obtained experimentally, probably on account of the formation of acid sulphate.

W. R. C.

1406. *Organic Electro-Chemistry.* **M. Krüger.** (Elektrochem. Ztschr. 5. pp. 240–246, 1899.)—This is a continuation of the author's series of historical papers (see 1898, Abstract No. 1185; and 1899, Abstracts Nos. 489 and 868), and relates to the action of electrolytic hydrogen upon organic nitro-compounds, and chiefly upon nitro-benzene under varying conditions. W. G. M.

1407. *Electrolytic Perchlorates.* **F. Winteler.** (Chem. Zeitung. 22. p. 90, 1898; also Ind. Electrochim. 3. pp. 3–4, 1899.)—Perchlorates can be formed by prolonged electrolysis of solutions of the alkali metal, or alkaline earth, chlorides. Platinum electrodes should be used. Chlorates are first formed. When all the chloride has been converted into chlorate, the best conditions for further conversion into perchlorate are: (1) Acidity of the solution at the anode; (2) low temperature of the solution at the anode; (3) a current density of 4 to 12 amperes per square decimetre at the anode; (4) a saturated solution as electrolyte. Under these conditions 73 to 95 per cent. of the oxygen liberated at the anode may be fixed as perchlorate. The electrodes should only have one surface in contact with the electrolyte. The formation of perchlorate is accompanied by that of ozone. Perchloric acid can be formed in a similar manner by electrolysis of hydrochloric acid. J. B. C. K.

1408. *Electrolytic Chlorates, Bromates, and Iodates.* **E. Müller.** (Zeitschr. Elektrochem. 5. pp. 469–473, 1899.)—This process is a result of experiments based on those of Forster and Jorre. The author has found that the addition of a small amount of a chromate salt to the electrolyte enables a very high current efficiency to be obtained without the use of diaphragms between anode and kathode compartments of the cell. Full details are given of the electrolytic apparatus used in these experiments, and of the chemical methods used for determining the electrical efficiency of the process.

The following figures were obtained in experiments, each of which lasted twenty-one hours:—

Sodium Chlorate	... current efficiency	67·9	per cent.
Potassium Iodate	" "	97·0	" "
Potassium Bromate	" "	89·8	" "

It was found that platinum formed the best anode material.

The author concludes his paper by presenting two theories to account for the remarkable action of the chromium salt in accelerating the oxidation of the electrolyte. According to the one, a thin film of chromic hydrate is formed over the surface of the kathode, and acts as a diaphragm to protect the oxygen salts in solution from the reducing action of the hydrogen liberated at the true surface of the kathode. According to the second, a film of an alloy of chromium and platinum forms upon the surface of the kathode, and acts in a similar manner.

It was found that chromates give better results than any other oxygen salts, manganates having little or no effect in accelerating oxidation of the electrolyte. J. B. C. K.

1409. *Verley's Method of Treating Syrup with Ozone.* (Ind. Electrochim. 3. pp. 25–29, 1899.)—The ozone generators of Verley are of the Berthelot type. A slab of slate is covered with aluminium. Glass bars 4 mm. thick are fixed on the aluminium; on these rests a glass plate, silvered on its upper surface. The air circulates in the space between the aluminium and the glass, the bars forcing it to describe a spiral before it escapes through an opening in the centre. In order to obtain electric currents of very high frequency a Hertz arrangement has been adopted. A condenser is placed on the silvered glass, and a spark-gap is interposed in the wire connecting the condenser with the aluminium. Verley works with long sparks, and calls this part of his apparatus the exploder. At Courbevoie he employs 140 such generators in a hall, whose temperature is maintained at 0° C. by means of a sulphurous acid refrigerator, for the production of vanillin, &c. The treatment of beetroot sugar syrup which Bouillaut has introduced at Noyon takes place during the winter months, so that artificial cooling is not required. The installation for the daily treatment of 200 tons of syrup comprises a 100 H.P. steam engine, an alternator for currents of 300 amperes at 250 volts, and 10 transformers, raising the tension to 12,000 volts, and each feeding 10 ozone generators, 100 altogether. The ozonised air is sucked through a column of coke impregnated with caustic soda for the absorption of the nitrogen compounds, and then through two (of three) sugar ozonisers, each of 70 hectolitres capacity, which are provided with several perforated false bottoms and agitators. The syrup is rendered slightly alkaline by means of lime, and cooled down to 20° C. The ozone is absorbed by the syrup, which turns dark. After about ninety minutes the gas passes freely through the syrup, and the colour becomes lighter again. An after-treatment with sulphurous acid and baryta seems to answer best. The process is stated to give a higher yield of a superior beetroot sugar, odourless and of pleasant taste. H. B.

1410. *Electro-metallurgy.* **E. Andreoli.** (Elektrochem. Ztschr. 5. pp. 236–239, 1899.)—The author deals with the Tommasi lead process (see 1898, Abstract No. 1383), the electro-deposition of nickel, and the Castner-Kellner (see 1898, Abstract No. 962), Hargreaves-Bird (see 1898, Abstract No. 832), and Hulin (see 1898, Abstract No. 417) electrolytic alkali processes. The greater portion of the article is devoted to processes for the extraction and recovery of gold.

The Cassel-Hinman and Haycroft processes are described. The former is non-electrolytic; the latter depends upon use of a hot solution of sodium chloride, and electrolysis with a mercury kathode. The proposals of Cowper-Coles to use aluminium as kathode in gold-cyanide solutions, and of the author to use lead peroxide as anode material are next dealt with. The cyanide treatment as applied to slimes is discussed, and it is stated that 76,000 tons of slimes have already been reworked in one year at the Robinson Mines. The electrolytic recovery process is considered by the author to be the only one applicable to the cyanide solutions obtained from these slimes on account of their dilution. They contain only 0·4 to 1·5 gram gold per ton of solution. Iron anodes can be safely used for electrolysis of these solutions, since a current density of only 0·03–0·04 ampere per square foot is used, and with this the iron is only slightly attacked. J. B. C. K.

1411. *Trustedt's Magnetic Concentration Plant.* (Elect. Engin. N.Y. 27. p. 221, 1899.)—In O. A. P. Trustedt's recently patented system for the concentration of magnetic materials, a row of electromagnets is excited by polyphase currents so that the magnetic field moves along from one end to the other, and carries the magnetic material with it. The non-magnetic material is carried away in a transverse direction by a stream of water or air.

W. R. C

1412. *Manufacture of Calcium Carbide with Three-Phase Currents.* **E. Segre.** (Bull. Ass. Ing. El. Liège, 10. pp. 161–186, 1898–1899.)—The author describes a calcium carbide installation at St. Marcel (Italy), which has been erected and designed by the engineer in charge, Mons. Memmo, with the view to using three-phase currents. The raw material is a mixture of wood charcoal and quicklime, intimately mixed and moulded into briquettes. The light weight of this form of carbon renders this necessary to avoid dust, which interferes with the regularity of the arc. The furnaces employed are either continuous or intermittent, and in both cases are of simple form. The three-phase current is introduced into the furnace by three carbon rods, inclined to one another at an angle. There are three arcs, formed either in the form of a triangle between the three carbons, or in the form of a cross between each carbon and a neutral piece of carbon between them. This latter may be connected to the neutral point of the dynamo. By using three-phase current there are less violent fluctuations of the current, as, if one arc fails through some local disturbance in the furnace, the other two arcs continue to employ current and thus prevent an undue strain on the dynamo. The paper includes a detailed description of the 800 H.P. turbine plant, and of the dynamos and electrical fittings designed specially for this method of working. There is also a full account of the working of the furnaces and the results obtained from them. J. L. F. V.

GENERAL ELECTRICAL ENGINEERING.

1413. *Iron-Consuming Batteries.* **A. A. Beadle.** (Soc. Chem. Ind. Journ. 18. pp. 332–333, 1899.)—The author considers the use of iron as the electro-positive element in voltaic cells. He has obtained good results by placing the iron in a porous pot and using ferric chloride as electrolyte. In this way the iron only reduces the electrolyte in the porous pot, that about the carbon being reduced only on closed circuit. The latter part of the electrolyte may be reoxidised by suitable reagents.
W. R. C.

1414. *Harrison Lead Peroxide Battery.* **J. D. Darling.** (Frank. Instit. Journ. 148. pp. 55–65, July, 1899.)—This battery consists of zinc opposed to lead peroxide in sulphuric acid. The E.M.F. is 2·45 volts. The lead peroxide is prepared electrolytically and compressed round a central conductor of lead that has been previously treated in a way that prevents sulphating. The zinc is in the form of a cup attached to an amalgamated copper conductor: this cup is filled with zinc amalgam which is solid when cold. When voltaic action takes place, enough mercury is liberated to keep the whole of the zinc amalgamated. Consequently local action is reduced to a minimum. In the larger cells mercury is placed at the bottom of the jar, and granulated zinc, lying in this mercury, is used for the positive plate.
W. R. C.

1415. *Capacity of Accumulators.* **L. Jumau.** (Écl. Électr. 18. pp. 201–203, 1899.)—The author studied the variation of capacity with strength of acid. The experiments were carried out upon pasted plates. The capacity at first increases and then decreases as the strength of acid is increased, but the concentration which gives the maximum rises with the rate of discharge. The same is true of the positive and negative plates separately: the maximum points, however, do not occur at the same values of the concentration, the capacity of the negatives falling off rapidly with a strong acid. The greatest capacity would result by separating the plates and having strong acid round the positives, and dilute acid round the negatives. This being impossible in practice, the strength of acid should depend upon the rate of working, and the area of the negatives should be greater.
W. R. C.

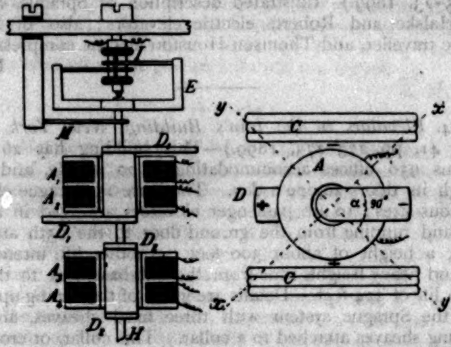
1416. *Accumulator Tests.* **M. Schoop.** (Ind. Élect. 8. pp. 29–31, 1899.)—The author emphasises the importance of studying the behaviour of the positive and negative electrodes separately by means of a supplementary electrode, and describes a special form of the latter which gives accurate results. The electrode consists of a pool of mercury at the bottom of a porous pot, covered with a thin layer of mercuric sulphate; the cell is filled up with dilute sulphuric acid, or with a gelatinous electrolyte formed by adding silicate of potassium to the dilute acid. A platinum wire insulated by a glass tube makes contact with the mercury. The porous cell is placed in the electrolyte of the cell to be examined; the potential differences between the terminals of the cell, and between the supplementary electrode and each terminal, are measured on open and closed circuit at intervals during charge or discharge at various constant rates. From the results curves are plotted showing the variation of E.M.F. and resistance for each plate, the period of exhaustion of the individual plates during discharge, &c. The author gives the curves for a pair of Gottfried plates, and briefly discusses the inferences to be drawn from them. (See also 1899, Abstract No. 1068.) A. H. A.

1417. *Accumulator Construction.* **D. E. Fitz-Gerald.** (Elect. Engin. 23. pp. 277–278, 463–464, 531–532, 564-565, 1899).—Continuation of articles on this subject. EDITOR.

1418. *Magnetic Cut-out.* **M. Schiemann.** (Zeitschr. Elektrotechn. 5. pp. 3–6, 1899.)—In this switch (which is very fully illustrated by drawings and photographs), after the circuit has been broken automatically by reason of a short-circuit, it is not possible to again complete the circuit through the main contact-arm of the switch until the short-circuit has been removed. This is effected by employing two contact-arms both actuated from one handle; viz., a main contact-arm, and an auxiliary contact-arm which engages with a fixed carbon contact-piece and serves to make and break contact, the main contact-arm following at a short distance behind. The armature of the controlling electromagnet is connected by linkwork with a finger which, if the short-circuit is not removed, and the auxiliary arm is brought into contact with its contact-piece, will stand in the path of a projection on the handle in such a position as to disconnect the main contact-arm from the handle before it engages with its contact-piece, the auxiliary arm also flying back. A suitable resistance is introduced into the circuit of the auxiliary arm. C. K. F.

1419. *Vulcain Energy Meter.* **M. Aliamet.** (Electricien, 17. pp. 193–198, 1899.)—This is a motor meter, and generally resembles the Thomson-Houston type. The details peculiar to the instrument are described, the chief novelty being in the brake, which consists of a light copper cylinder acted on by a ring of magnets; the latter can be raised or lowered simultaneously by a screw, thus altering the damping and affording a ready means of adjusting the calibration. By various refinements the friction has been reduced so much that the constant loss in the shunt circuit is under 3 watts, while the motor starts with 0·14 per cent. of its normal full load. The article concludes with a brief account of the method of calibration, and a calculation showing the importance of a small loss in the shunt. A. H. A.

1420. *Peloux Energy Meter.* (Écl. Électr. 19. pp. 36–37, 1899.)—In the earlier form of this meter the main current is led through a simple armature, consisting of two coils set at right angles, one below the other, in a magnetic field produced by fine wire coils in shunt to the circuit. These coils are excited in proper order by means of a two- or four-part commutator, so as to maintain the rotation. In an improved form (see figure) there are no moving coils; the armature consisting of two **Z**-shaped iron inductors, D_1 D_2, set at right angles, which are magnetised by stationary coils, A, &c., of fine wire in shunt, and rotate in a magnetic field produced by the main current flowing in coils, C. The spindle H carries brushes, E, which bear on a fixed commutator, I, and excite the shunt coils in the proper order. The lower end of the spindle carries a magnetic brake. The apparatus is very efficient and accurate. A. H. A.



1421. *Meters.* **H. Armagnat.** (Écl. Électr. 18. pp. 331–336, 407–412, 457–461, 494–498, 1899.)—Illustrated descriptions of supply meters including those of Hummel, Aron, Ferranti, Cauderay, Beaumont, Browne, Emmot, Watson, Bastian, Evershed, Hookham, Feldmann, Steinmetz, Shand, and Thompson and Pratt. EDITOR.

1422. *Measure of Horse-Power.* (Engineer, 87. pp. 227–228, 1899.)—This paper contains in tabular form a number of numerical equivalents of 1 H.P. In one section the equivalents are given in terms of the working force and the distance worked in a certain time—*e.g.*, mile-tons, foot-pounds, kilogram-metres, per hour, per minute, and per second respectively. In hydraulics, the equivalents are expressed in terms of quantity of water and of pressure expressed in various ways. In the same way a number of thermal equivalents are expressed—*e.g.*, heat units, steam evaporated, or fuel burnt, per unit of time. A. S.

1423. *Cranes and Elevators.* **G. Richard.** (Écl. Électr. 19. pp. 15–23, 1899.)—Illustrated description of Sprague, Siemens and Halske and Roberts electric elevators; also of Sawyers electric traveller, and Thomson-Houston electric compressor.

EDITOR.

1424. *Elevators in the Ivin's Building, New York.* (Eng. News, 41. pp. 273–275, 1899.)—This building has 26 floors, contains 950 offices accommodating 4,000 people, and passes through its doors 20,000 a day. There are 15 Sprague elevators of various sizes; 10 are passenger elevators arranged in a semicircle and running from the ground floor to the 25th and 26th stories, a height of about 300 feet. Another lift, intended for safes and heavy freight, runs from the sub-basement to the 25th floor, a lift of 324 feet. Details are given of the roping-up, which is on the Sprague system with three fixed sheaves, and four travelling sheaves attached to a collar. This collar, or crosshead, is driven by a ball-bearing nut on a vertical screw about 23 feet long and 3 inches in diameter, which is driven by a vertical motor. The ratio of the travel of the nut and the travel of the car is 1 to 16. The car is counter-weighted by the cables, together with a small multiplying travelling counter-weight, provided with a chain to counter-balance the varying weight of cable suspended from the counter-weight. The ball-bearing nut, whose travel along the screw drives the collar to which the cables are attached, is only prevented from turning by its friction against the collar. This arrangement provides an easy safety device for over-winding, as it is only necessary to interfere with the travel of the nut when it will rotate with the screw instead of moving along it. The usual slack-cable, no-current, and other safety devices are provided. The method of controlling is by means of a Sprague pilot motor, worked by a small hand-switch in the car; this switch is connected by a cable containing six wires with the operating switchboard in the basement. Each car has one panel on the board. Two of the six wires are for the car lights, one for the car switch, one for "up," one for "down," and one for "stop." If the car switch is moved on to the "up" point, magnetic switches on the board are operated, throwing the line current into the main motor armature, through sufficient resistance to just hold the armature while the brakes of the main and pilot motor are released, and the armature of the latter begins to revolve and rotate a rheostat arm. This cuts out the main armature resistance and thus increases the speed and torque of the main motor. To stop the car, the operator simply leaves go of the switch handle, when the rheostat arm is automatically revolved back into the off position. The car descends entirely by gravity, the armature of the main motor first being short-circuited, and then resistance gradually cut into the armature circuit by the pilot motor, thus increasing the speed of the car. As it reaches the bottom, an independent retarding circuit is introduced while the resistance in the armature circuit is gradually reduced. The average hoisting current for the average live load in the car will not exceed 175 amperes at 120 volts, while the kilowatt hours per car mile will not exceed 3½.

E. H. C.-H.

1425. *Motors in a Printing Office.* **C. A. Dresser.** (Elect. World, 33. pp. 233–234, 1899.)—With ordinary driving, the plates are put on to a Hoe press by two men, one using a foot pressure friction clutch and another signalling the exact points of stoppage. Rolls of paper (2,000 lb.) are placed at one end of the press, and two operators thread the sheet cautiously through its intricate path, which is about 60 feet in length; the jerky motion of the machine resulting from mechanical driving often breaks the paper and requires a repetition of the process. In the press room of the *Chicago Daily News* two motors are used, one a 5 H.P., 6-pole motor at 200 r.p.m. The speed of the press at the maximum speed of this 5 H.P. motor is 10 r.p.m. The speed regulator is moved by a compressed air cylinder with dash pot, controlled from four points on the press having 4-way compressed air-cocks. By manipulating an air-cock, the operator can move the cylinder on the press any distance down to $\frac{1}{16}$ inch. The main power for the press is derived from 40 H.P., slow-speed multipolar motor. The motor controller has 55 contact points, controlled from nine push-button stations, each also containing compressed air-valves. The paper from the main roll passes over two tension rollers, which are released when the paper is broken, and which shut down the press. In the basement below each press is a roll holding 8,000 lb. of paper. These rolls are driven by motors which bring to position a new roll whenever one s used up. At $\frac{1}{20}$ full speed a new paper strip is pasted on to the end of the old, and in thirty seconds the press is again operating at full speed, namely, 24,000 sixteen-page papers per hour.

M. O'G.

1426. *Constants for Power Transmission.* (Eng. News, 41. p. 220, 1899.)—The constants used in the calculation of lines for alternate-current transmission are here tabulated for gauges of wire from 102 to 460 mils, for lengths of 1,000 feet and 1 mile respectively, under the headings: (1) Resistance at 75° F.; (2) Inductance in milhenrys; (3) Capacity in microfarads; (4) Current at 100 cycles and 10,000 volts to neutral, *i.e.*, in a 20,000-volt single-phase and a 17,300-volt three-phase line; and (5) Reactance at 25, 40, 60, and 125 cycles respectively. R. A.

1427. *Electric Siren.* **D. H. Keeley.** (Canad. Elect. News, 9. pp. 37–38, 1899.—This is a description of an electric fog-horn invented by A. G. Trudeau of Ottawa. It consists of two huge funnels made of $\frac{1}{4}$ inch copper. Each of the funnels projects 6 feet 6 inches from the stand at right angles to each other. In each of these funnels or horns a vibrator or sound producer is placed, the object being to use them alternately or simultaneously as may be desired. The diaphragm is said to be of a specially prepared material and of magnetisable character, a suggested modification being one of bell metal or other non-magnetic material provided with small projections of iron to serve as armatures for the actuating electromagnets, and it is secured in the frame by an annular clamp, somewhat after the fashion of a drumhead. A screw device by which the amplitude of the vibrations of this diaphragm is to a certain extent regulated, is mounted opposite the centre in a crosspiece at the back. A group of electromagnets, made up of laminated iron cores wound in the ordinary way, is fixed in the frame. The stand is surmounted by a large hollow cast iron sphere, from which the horns project. This sphere is divided into two, the back portion opening on a strong hinge. The vibrator is self-contained, and may be taken out and replaced by another in a moment. The instrument is operated by means of alternating currents. W. G. R.

1428. *Flow of Steam through Pipes.* **R. C. Carpenter** and **E. C. Sickles.** (Mech. Eng. 3. pp. 389–390 and 413–415, 1899. Paper read before the American Society of Mechanical Engineers, December, 1898.)—The experiments described were made to determine the coefficient of friction of steam flowing at different speeds through pipes and fittings. The measurements of condensation and flow were made on a 90-feet length of piping 2 inches diameter, leading from the Sibley College boiler rooms. Accurate and carefully calibrated steam gauges, subdivided to read fractions of a pound, were used to determine the pressures. Steam separators and throttling calorimeters were used to determine the quality of the steam.

If E be the total loss of energy, E_c the dynamic condensation energy, and E the loss by friction, $E - E_c = E_f$. Many expressions for the value of E_f are given by various writers; the authors reduce all their experimental results to Unwin's formula—

$$E_f = f\frac{V^2}{g}\frac{2}{d}WL.$$

The value of f depends on the velocity, and, for velocities of 100 feet per second, is expressed by Unwin's formula—

$$f = K\left(1 + \frac{3}{10d}\right)$$

in which K is the coefficient to be found by experiment. If p be the loss of pressure in pounds per square inch, D the weight of the fluid per cubic foot, and w the flow in pounds of steam per minute—

$$p = \frac{1}{20 \cdot 66}K\left(1 + \frac{3.6}{d}\right)\frac{w^2 L}{Dd^5}.$$

For a 2-inch pipe this reduces to $p = 1447\,\frac{w^2 K}{D}$.

In the first set of experiments, in which the steam was discharged through a ¾-inch nozzle, the highest value of K was ·00276, the lowest ·00180, the average ·0021. Neglecting the lowest value, which was considerably less than the others, the average value of K was ·00234. In the second set of experiments, in which the steam was discharged through a ⅞-inch nozzle, the average value of K was ·00298. The friction in elbows and valves was measured by the same apparatus, and taking the formula—

$$H_e = f_e\frac{V^2}{2g}$$

where H_e is the loss of head in feet for elbows, f_e for 90° elbows was found to be 5·6, for globe valves 8·2, and for gate valves ·005.

A table is calculated giving the delivery in pounds per minute by pipes of various diameters and lengths, for an absolute pressure of 100 lb. and a drop in pressure of 1 lb. A diagram of reduction factors for different steam pressures and different drops in pressures is given, so that it is easy by using the tables and the curves to determine the flow of steam through a pipe under any set of conditions. A. S.

GENERATORS, MOTORS, AND TRANSFORMERS.

1429. *Induction Generators.* **Leblanc.** (Écl. Électr. 18. pp. 488–491, 1899.)—The article contains an elaborate mathematical theory of the special form of exciter for induction generators described in Abstract No. 908 (1899). A. H.

1430. *Analysis of Dynamo Losses.* **G. Dettmar.** (Elektrotechn. Ztschr. 20. pp. 203–205 and 218–220, 1899.)—The following method, which for a number of years has been used by the author, allows of a complete analysis of the various losses taking place in a dynamo. The machine under test is run as a separately excited motor, the exciting current and P.D. across the brushes being varied while the speed is maintained constant. The values of the P.D. and the armature current are noted. Several such sets of readings are taken, each set corresponding to a definite speed. From the readings curves are plotted on squared paper, the E.M.F. being represented by abscissæ and the corresponding watts absorbed by the armature by ordinates. By producing each curve backwards until it intersects the axis of watts we obtain the watts absorbed by friction at the speed corresponding to the curve. If the exact shape of the curve close to the axis of watts should appear doubtful, the value of the intercept F on that axis may be obtained from the fact that each curve may be represented by an equation of the form $w = F + aE^2$, where w denotes the watts, E the E.M.F., and F and a are constants for each curve. Having found the values of F for the various curves, we plot a new curve, with speeds as abscissæ and values of F as ordinates. From this curve the watts absorbed by friction at any given speed may be at once read off. Numerous experiments on a number of different machines have shown that this curve is never a straight line, but that it is concave upwards, showing that the resisting torque due to friction increases with the speed. The machine is next run under normal excitation, readings of the speed, P.D. across brushes and armature current being taken as before. From these a curve (α) is plotted, with values of the E.M.F. as abscissæ and those of the armature current as ordinates. From each ordinate of this curve is subtracted an amount representing the current required to overcome frictional resistances at the corresponding speed; this current is equal to the quotient of the watts absorbed by friction at that speed (obtained from the F-speed curve) by the E.M.F. The ordinates of the new curve (β) so obtained represent the currents required to overcome the hysteresis and eddy-current torques. The intercept on the axis of current gives the current required to balance the hysteresis torque. By drawing a straight line (γ) parallel to the axis of E.M.F. through the point of intersection of

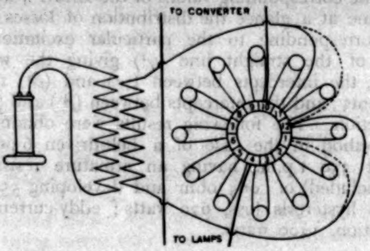
(β) with the axis of current, we determine the currents required to balance the eddy-current torque; these currents being represented by the vertical intercepts between (β) and (γ). Finally, by drawing an additional set of curves (α^1), (β^1) and (γ^1), obtained by multiplying the ordinates of (α), (β) and (γ) respectively by the corresponding values of the E.M.F., we are enabled to determine at a glance the distribution of losses for any given E.M.F. corresponding to the particular excitation used: the ordinates of the straight line (γ^1) giving the watts lost by hysteresis; the intercepts between (γ^1) and (β^1) those lost by eddy-currents; and the intercepts between (β^1) and (α^1) the watts lost by friction. The following results were obtained by means of this method in the case of a belt-driven 6-pole generator running at 550 r.p.m., having an armature resistance (brush contacts included) of ·005 ohm and developing 550 amperes at 110 volts: hysteresis loss, 670 watts; eddy-current loss, 1826 watts; friction, 1400 watts. A. H.

1431. *Dynamo Testing.* **C. Liebenow.** (Elektrotechn. Ztschr. 20 pp. 274–275, 1899.)—The author describes a method practically identical with that used by Routin (see 1898, Abstract No. 199), and gives the following results obtained with it in the case of a 150-kilowatt generator developing 2,300 amperes at 65 volts and 254 r.p.m., and having an armature resistance of ·001665 ohm.

Bearing friction......................	·41 kilowatt
Brush „	·69 „
Hysteresis loss	·43 „
Eddy-current loss..................	2·00 „
Loss by heating of armature ...	8·80 „
„ „ „ field coils ...	2·27 „
Total loss..................	14·6 kilowatts

The efficiency is therefore 91·1 per cent. A. H.

1432. *Armature Testing.* **W. H. Hall.** (Elect. World and Elect. Engin. 33. pp. 407–408, 1899.)—The accompanying figure illustrates the method of test. Open one side of a lamp circuit carrying from 5 to 20 amperes alternating current, and clamp the two ends of the break to opposite segments of the commutator, using a clamp that will not make a short circuit. If coils and commutator are perfect, this will divide the current into two equal parts. Prepare an induction coil with primary of very low resistance, and connect the secondary with a good telephone receiver. Proceed to test the coils of the upper half of the armature with two ends of the primary, keeping the receiver to the ear. In the figure, the coil connecting segments 1 and 12 is broken, and therefore no sound is heard until the wires from the primary span these segments, when the sound will be very loud, locating at once an open circuit in the coil, which may be marked. Temporarily short-circuit these two segments, and proceed to test other coils.



When an alternating current is not available, a number of primary cells in multiple may be used, with a good interrupter in the circuit. W. G. R.

1433. *Dynamos*. **C. F. Guilbert.** (Écl. Electr. 18. pp. 417–421, 1899.)—An illustrated description of recent patents. Editor.

1434. *Fan Motors*. (Amer. Electn. 11. pp. 155–163, 1899.)—An illustrated description of a variety of fan motors. Editor.

1435. *Rotary Converters*. **R. B. Ritter.** (Écl. Électr. 18. pp. 20–30, and 48–55, 1899.)—These are two articles on the manufacture and running of rotary converters. The descriptive part is confined to Alioth converters installed at various stations. W. G. R.

POWER DISTRIBUTION, TRACTION, AND LIGHTING.

1436. *Storage in Traction Power Stations.* **R. McA. Lloyd.** (Amer. Instit. Elect. Engin. Trans. 16. pp. 59-74, 1899. Discussion, pp. 75-103.)—In very many American stations the average load is far less than the maximum load, and the latter is far below the capacity of the generating plant, so that the efficiency of the plant is very low. The author urges the value of storage for rectifying this fault, and considers three sizes of battery : "small," to level the momentary fluctuations ; "medium," to level the hour-to-hour variations ; and "large," to level the load curve over the whole day and night. In the first case, capacity is unimportant, but high rate of discharge is essential ; the battery will cost less than generating plant for the same duty, and will be able to run a few cars and lamps at night when the engines are stopped. In the second case the battery will cost twice as much as a "small" battery, but will still cost less than the generating plant displaced, and will increase the efficiency of working to a marked extent. Lastly, a "large" battery will cost twice as much as a "medium" one, will cost as much as the generating plant displaced, and will be able to carry the whole load for some hours. The efficiency will be still higher, as the machinery will run at constant load, and the labour charges will be less. The following table shows the relative results for a stated case :—

Outlay with		Cost of generating plant.	Cost of Storage Battery.	Total cost of station plant.	Cost of Coal per day.	Cost of Coal per annum.	Sav'g in Coal.	Saving in coal and saving in int. 5 p.c.
1	No Battery	$115,000	$	$115,000	$30	$10,950	$	$
2	Small Battery	60,000	20,000	80,000	25	9,125	1,825	3,575
3	Medium "	50,000	35,000	85,000	20	7,300	3,650	5,150
4	Large "	40,000	70,000	110,000	15	5,475	5,475	5,525

Cost of Real Estate and Buildings.		Repairs and Deprecia-tion.	Saving in Labour per annum.	Saving in water, oil, waste, &c.	Total Saving.	Estimated Addition to receipts.	Net Advantage in opera-tion.
1	All the same	All the same		$	$	$	$
2				100	3,675		3,675
3				200	5,350	1,000	6,350
4			$1,200	300	7,025	5,000	12,025

The author allows 10 per cent. per annum for repairs and depreciation on the entire station plant, including the battery. He suggests that all electric supply should be carried out with rotary converters and storage batteries from large stations working at constant load and distributing at high pressure, and believes that the most profitable proportions of plant investment are 30 per cent. generating machinery and 70 per cent. storage battery. The paper is illustrated with a number of load curves showing the effect of storage in actual cases.

In the discussion, **G. Hill** strongly supported the author's views, and described an instance of electrical supply where a large saving was effected by the use of complete storage. He pointed out cases where, on the other hand, storage would not be advantageous. **C. O. Mailloux** and **E. T. Birdsall** agreed with the author, and **J. M. Smith** described a test bearing out his facts. **H. B. Coho** considered 10 per cent. depreciation too high for machinery and low for batteries. In reply, the author pointed out that when the battery plates are renewed the best types are used, so that the battery is always nearly up to date; whereas machinery becomes obsolete.

In the discussion at Chicago, **A. Dow** supported the author, but considered that an engine with a heavy flywheel was ample provision for the momentary fluctuations, and that "small" batteries were most useful as regulators at the end of feeders. **J. Appleton** stated that 6 per cent. was fair for the actual depreciation of cells, but **M. Coster** preferred 10 per cent. **B. J. Arnold** said the cost per kilowatt-hour of storage batteries varied from £8 for low discharge rates to £35 for high rates. **J. Appleton** described an instance of a "small" battery at a feeding-point nine miles from the power station; the maximum load was 1,000 amperes, but the current supplied through the feeder was 400 amperes continuously. The energy efficiency of the battery under these conditions of intermittent charge and discharge, as measured, was 90 to 95 per cent. Other instances were described showing the saving in copper and machinery. The reason of the high efficiency was the short duration of the charge and discharge periods: the number of cells must be carefully adjusted to obtain the best effects.

A. H. A.

1437. *Increasing the Utilisation of Central Station Plant.* **A. Meynier.** (Ind. Élect. 8. pp. 78–81, 1899.)—The author describes an instance where a saw-mill was driven by turbines, the speed of which varied from 15 to 75 r.p.m., on account of the extreme variations of load. To remedy this, a dynamo was coupled to the turbines and joined to the supply mains; during heavy loads the machine receives power from the mains, and assists the turbines, while during light loads the dynamo absorbs the surplus power of the turbines and delivers it to the mains, the speed remaining nearly constant. During the day the former action predominates, and during the time of heavy load on the mains the latter occurs, the duration of each being regulated by the meter readings so as to make the amount of energy supplied equal to that restored. Similar arrangements are outlined, by means of which it is urged that the output of the station could be maintained practically constant at all times.

A. H. A.

1438. *Electric Traction.* **C. P. Feldmann.** (Elektrotechn. Ztschr. 20. pp. 144–147, 1899.)—This is a paper read before the Elektrotechnische Gesellschaft at Köln, in which the various systems of electric propulsion on ordinary railroads are discussed.

C. K. F.

1439. *Electric Tramways.* **G. Conaty.** (Railway World, 8. pp. 110–114, 1899. Paper read before the Birmingham Association of Mechanical Engineers, February, 3, 1899.)—The author discusses generally the equipment of electric tramways. With regard to permanent way he is in favour of pitch pine longitudinal sleepers bedded in concrete. The sleepers to be 9 in. × 4½ in. This gives the necessary elasticity, and will diminish the repairs necessary to both permanent way and rolling stock. W. R. C.

1440. *Cost of Speed in Rapid Transit.* **J. R. Cravath.** (Elect. World and Elect. Engin. 33. pp. 400–402 and 437–439, 1899.)—The speed curves for a transit service consist of three parts: First, acceleration up to a certain maximum speed. Second, a period of time, however short, between the time maximum speed is attained and the time brakes are applied, and during which time the motors may be either coasting with current off or running with current on to overcome the train friction only. Third, retardation or braking, during which time the energy stored up in the train is wasted in the brake to bring the train to rest.

It is evident that if it is required to run, say, 2,000 feet in a given time, the greater the acceleration the less will be the maximum speed necessary to run the distance in that time and the less the energy that must be wasted in the brakes at the end of the run. The acceleration should also be rapid and the maximum speed low, because with an electric motor the current required to produce a given acceleration varies directly as the speed for which the motor is wound or geared. With a rapid acceleration it is better to make the maximum speed fairly high and then switch off the current and allow the train to drop below its average speed before applying the brakes.

As the weight of train on the drivers has an important bearing on all rapid transit schedules, three cases of electrical equipment are considered: First, four-car elevated trains with a motor car at the head of the train. Second, four-car elevated trains with half the axles on the train motor driven as in the multiple unit system. Third, four-car elevated trains with all the axles motor driven on the multiple unit system.

The maximum horizontal effort that a motor car can exert on a dry track is usually accepted to be one-fourth the weight on the drivers, or 500 pounds per ton on the drivers.

To allow for slippery track the author assumes that the maximum horizontal effort is 350 pounds per ton on the drivers.

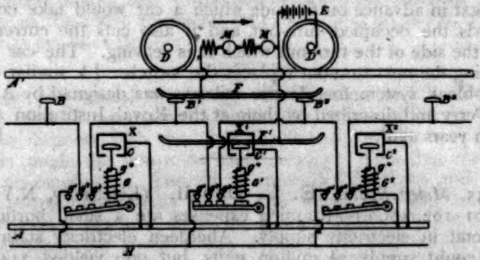
One of the first things to be noticed about the calculations on energy consumption per run is the large amount of energy taken to keep the train in motion after it is up to speed where there is a considerable run at maximum speed. This is most noticeable in the case of the multiple unit train with four motors per car and is the least with the single motor car train. The reason for this is that in the multiple unit trains the motor capacity is larger in proportion to the weight of the train than with the single motor car because of the more rapid accelerations that must be provided for. The importance of using the coasting method as much as possible is greater with the multiple unit system than with the single motor car. The maximum economy of the motor car system is less than the multiple unit, but if the multiple unit system is not rightly used it may show an economy much lower than the lowest with the motor car under conditions that may occur in practice. The possibilities both in great economy and greatest lack of economy are with the multiple unit. As regards cost of maintenance the motor car has the advantage. W. G. R.

1441. *Rail Bonding.* **C. Thonet.** (Électricien, 17. pp. 150–152 and 171–173, 1899.)—This paper is a report presented to the tenth annual meeting at Geneva of the *Union Internationale Permanente de Tramways.* Mention is made of the methods of bonding used by a number of Continental tramway companies, and the conditions which should be realised are discussed. The following conclusions are arrived at: 1. The negative of the dynamo should be connected to the rails. 2. The cross section of the bonding should be ample. The rails should be cross-connected every 50 metres; and, in the case of double lines, the two lines should be connected. 3. Return feeders of suitable cross section should be connected to certain points of the network. 4. Where corrosion is detected the potential should be equalised. W. R. C.

1442. *Surface-Contact System of the Union Elektricitætsgesellschaft.* **M. Kubierschky.** (Élektrotechn. Ztschr. 20. pp.

295–301, 1899.)—A full description is given of this system, the connections of which are shown in the figure below.

The only moving part of the relay switch is a heavy iron plunger which is a loose fit in a metal tube and is pulled up with a force of 5 kilograms by 12 amperes round the spool, thereby closing three carbon contacts carried on triangular projections at the bottom of the plunger. Sparking at the surface knobs is provided against. A four-cell battery makes the first contact and is afterwards kept charged by part of the motor current. The studs are in two rows, a "high-tension" row connected through the switch to the line, and a "low-tension" row connected to earth through the relay magnet. The low-tension studs are surrounded by an earthed ring through which any leakage current will flow direct to earth without magnetising the relay. Another point claimed is that the relay spools are in series with the motors and on their earthed side. The switches are independent and can be grouped in substations. E. H. C.-H.



1443. *Murphy Third-Rail System.* **E. V. Baillard.** (Eng. News, 41. p. 303, 1899.)—This system requires 180 switches per mile of single track, and these switches constitute one-third of the total cost of outside construction. Depreciation on the switches may be written at 10 per cent. and on the track 1 per cent., giving a total of $4\frac{1}{3}$ per cent. for the whole outside construction, as against 15 per cent. allowed by conservative engineers for overhead trolley construction. Figures are given of the leakage from 15-feet live sections covered with water, mud, and salt, showing under worst conditions 12 amperes leakage: no particulars are given as to the amount of street refuse present in the mud. The present switches hold up with 12 amperes, whilst the minimum current required to operate the car varies from 16 to 20 amperes, and it is therefore intended to set the switches for a minimum current of higher value. (See also 1899, Abstract No. 523.) E. H. C.-H.

1444. *Automatic Block System.* **C. F. Bancroft.** (Eng. News, 41. pp. 330–331, 1899.)—Illustrations are given of an automatic-block system for high-speed electric cars, which has been in successful operation for the past six months on a branch of the Lowell and Suburban Railway in Massachusetts, and which is now installed on the main line of that railway. It is designed for single-track roads using turn-outs, and is so arranged that each car as it advances operates switches controlling the turn-out which it is on, and the one next in advance. The apparatus consists of contact-plates placed at the turn-out approaches and exits, with automatic magnetic switches which are so interconnected that when a car leaves a turn-out it cuts the current off from the turn-out next in advance on the side which a car would take coming towards the occupied turn-out, and it also cuts the current off from the side of the turn-out which it is leaving. The car upon reaching the next turn-out replaces the switch. [A similar automatic-block system for electric railways was designed by Ayrton and Perry and described by them at the Royal Institution about fifteen years ago]. R. A.

1445. *Meter Rates.* **E. L. Debell.** (Electricity, N.Y. 16. pp. 101–102, 1899.)—Running expenses are a small portion of the total in electricity supply. Aberdeen electricity station in 1897 could supply 3¼ million units, but only yielded 214,000. The best consumer employed 2 H.P. of the station's capacity (less than £80 of its capital, *i.e.*, £5 10s. of the annual capital charges), employed the service for 2,000 hours, and produced a revenue of £57 10s., namely £52 over the capital charges. The worst consumer employed 177-H.P. (£7,400 of the station's capital, *i.e.*, £5,100 of the annual capital charges), used the service for only 61 hours, and paid only £164, namely, less than one-third of its proportion of the capital charges. To overcome this injustice various devices are recommended: 1. Wright's Demand Indicator. 2. The General Electric 2-rate meter. 3. The Oxley multiple rate meter switch. 4. A fixed rate per lamp wired plus a smaller charge for current. M. O'G.

1446. *Meter Rates.* **K. Wilkens.** (Elektrotechn. Ztschr. 20. pp. 262–263, 1899.)—The author deduces the two following equations for the prime cost of a kilowatt-hour for lighting (S_L) and for power (S_K):

$$S_L = \frac{B}{L+K} + \frac{Z}{L + \dfrac{K \cdot d_L}{d_K}}$$

$$S_K = \frac{B}{L+K} + \frac{Z}{K + \dfrac{L \cdot d_K}{d_L}}$$

where B = the total expenses dependent on the amount of energy delivered; Z = the total fixed expenses; L = the total useful energy delivered for lighting; and K = the total useful energy delivered for power (thus $Z+B=S_L . L+S_K . K$); d_K = the time during which each kilowatt is used for power, and d_L = the time during which each kilowatt is used for lighting. The following example is given: A central station having a capacity of 600 H.P. delivered 100,000 kw.-hours for light (L), and 500,000 kw.-hours for power (K). Since the corresponding [? average] values were 500 kw. for light and 435 kw. for power, $d_L=100{,}000/500=200$ hours, and $d_K=500{,}000/435=1{,}150$ hours. $B=67{,}000$ marks and $Z=80{,}000$ marks. On inserting these values in the above equations, we have $S_L=53{\cdot}96$ and $S_K=18{\cdot}61$ pfennigs per kilowatt-hour. C. K. F.

1447. *Differential Arc Lamp.* **C. Vigreux** and **L. Brillié.** (Ind. Élect. 8. pp. 59–62, 1899.)—The object of the inventors was to dispense with the ohmic resistance usually required to enable single arc lamps to burn steadily. This they claim to have accomplished. The arc is controlled by series and shunt coils acting differentially on a brake which oscillates on knife-edges, and a flywheel driven by gearing from pulleys to which are attached the cords which support the carbon-rods. The description of the lamp cannot be abstracted. It is stated that these lamps can be used singly on 45-volt circuits, two in series with 85 volts, three in series with 110 to 135 volts, and so on. Some calculations are given, and an actual installation described, to show the gain in efficiency due to the use of these lamps.

A. H. A.

1448. *Working Arc Lamps Three in Series.* **W. Wedding.** (Elektrotechn. Ztschr. 20. pp. 263–265, 1899.)—In this paper the author describes experiments made with Messrs. Körting and Mathiesen's system of running three differential arc lamps in series with each other and with a starting resistance, which is gradually cut out after turning on the current, across 100-volt mains. The electrical and photometric measurements made are given in tables and curves, the most important results being as follows: With a pressure across the mains of 110 volts and a current of 7·6 amperes, each lamp absorbed 279 watts and gave a light = 587 C.P.; with a current of 7·9 amperes, each lamp absorbed 289 watts and gave a light = 572 C.P., the mean result being 2050 C.P. for 1 kilowatt. C. K. F.

1449. *Arc Lamps.* **G. Richard.** (Écl. Électr. 18. pp. 174–182, 1899.)—A description of various lamps. Editor.

TELEGRAPHY AND TELEPHONY.

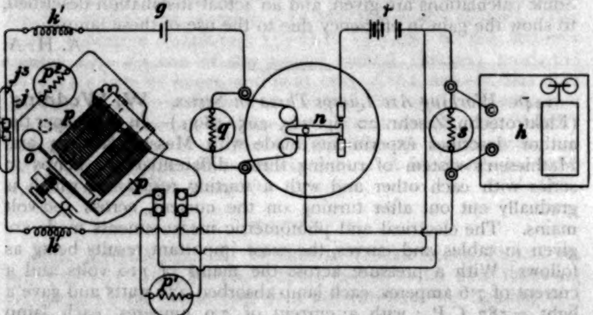
1450. *Induction Telegraphy.* **J. Voisenat.** (Écl. Électr. 19. pp. 23–27, 1899.)—General discussion, and consideration of Lodge's, Evershed's, and Preece's papers. (See 1899, Abstracts Nos. 960, 961, 962.) M. O'G.

1451. *Tall Wires in Wireless Telegraphy.* **R. Kennedy.** (Elect. Rev. 44. pp. 583–584, 1899.)—Starting from the ordinary formula for E.M.F. induced by a changing magnetic flux F in a coil of r turns at a frequency n—

$$e=4{\cdot}45\ \mathrm{F}\,rn\ 10^{-8}.$$

The author suggests that the tall wires correspond to coils having half a turn. F is small, but n, the frequency, is supposed high enough to give E a value whose fluctuations are noticeable with a coherer. M. O'G.

1452. *Wireless Telegraphy.* **G. Marconi.** (Instit. Elect. Engin. Journ. 28. pp. 273–290, 1899. Discussion, pp. 291–297.) —Transmission is effected by a long or short closing of the primary of a 10-in. coil connected to small spark knobs in air. No care is taken to polish these knobs. The receiver connections in the fig. show at p²,q,s, the non-inductive shunt resistances across all spark terminals. The resistance of the coherer falls to between 500 and 100 ohms. The inertia of the Morse instrument causes the *dash* to be printed as a dash, in spite of the rapid intermission at the relay. No results would be obtained across a hill without a tall wire capacity. A horizontal wire of 300 ft. added to a wire



30 ft. high tended to the disadvantage of signalling. Signals were transmitted over the following distances :—

Between the Isle of Wight and a steamer, mast 60 ft. high, distance 18 miles.
" Ballycastle and Rathlin, masts 100 ft. and 80 ft., distance 25 miles.
" Kingstown and a steamer, masts 110 ft. and 80 ft., 25 miles.
" Osborne House and a steam yacht, masts 100 ft. and 83 ft., 7 miles through a hill.
" South Foreland Lighthouse and East Goodwin, mast 80 ft. high, 12 miles.

Many wire stays about the lower 60 ft. of the masts had no noticeable effect, but the lighthouse on Rathlin was thought to diminish the clearness.

J. A. Fleming sketched an experimental coherer and confirmed the negative effect of horizontal wires. **E. Murray** considers a tall wire effect to be similar to an increase of tension at a point in a conductor. **W. P. Brett** has suddenly broken the earth connection while signalling over 12 miles and found no alteration in definiteness. **Capt. Kennedy** had used balloons and kites for the vertical wire. **J. Gavey** quoted examples of the law that the speaking distance varies as the product of the heights of the wires. With vertical wires syntony does not come into effect. Higher conductors are required over land than over sea, a result confirmed by Slaby. The height now required to speak over one mile of sea is 20 ft. A good earth contact was unnecessary, and a small capacity could be substituted for metallic continuity at the receiving end, but not at the transmitting end. Good results depended more on high frequency than on the amount of energy, thus five amperes with a 6-in. spark was better than 10 amperes with a 20-in. spark with the same coil and with contact-breaker so screwed up that the frequency was less. Up to half a mile reflectors were most useful, but beyond that they were disappointing. To screen the receiving apparatus from the violent effect of the transmitter in the same station Jackson and Marconi had adopted different ways. Protection from lightning deserved consideration. **M. O'Gorman** had made some experiments with coherers and small voltages, and suggested that as alternating currents are transmitted along the earth's surface if the frequency is high, the reversals of potential due to these currents would tend to charge the tall wire through the coherer. This explains earth conduction, the use of tall vertical wires, and allows for an earth connection consisting merely of a capacity. **L. B. Miller** had found several spark-gaps an advantage. A receiver wing need not make electrical contact with the coherer to be effective. **A. C. Swinton** had found that the resistance of a carbon coherer was affected by Hertz waves, and **A. C. Brown** stated that the change was gradual. **C. A. Stephenson** preferred inductive methods with a coil of cable for lightships, pointing out that Blake's conduction method had answered at Sandy Hook and his own experiences with electromagnets were satisfactory. The damping action of the earth on induction from horizontal coils is small. **S. P. Thompson** explained the advantage vertical wires derived from the reflective action of the conducting earth. If the vibrations are polarised a transparent reflector parallel to their plane would more readily reflect them, but the case is different with a metallic or conducting reflector. The greater absorption of rays travelling over land compared with water may be due to the greater conductivity of land. The mirror must be much larger than the oscillator and at a distance greater than a quarter wave from it: this implies a mirror five times the height of the vertical wire; and as the wave-length is about double the length of the wire, it implies an enormous mirror. **G. Marconi**: The oil spark-gap was abandoned because too variable. A little mercury is used in the coherers, and they are exhausted to about 1 millimeter. Coherers containing air diminish in sensitiveness. Earth connection at both stations is necessary for maximum distances, but even the vertical wire may be disconnected if its extremity is near the coherer, say 1 foot. The law of heights is discussed in the Ellettricista, August, 1897; in the Rivista di Artiglieria e Genio, 1897–98; and in a lecture by Bongiovanni at Ferrara, November, 1897. Screening from the transmitter is effected by enclosing all but the inker or recorder in an iron case, and interposing choking coils between the recorder connections. Fifty dry cells are now used at Osborne House; 100 dry cells at Alum Bay. If the conductor wires are slanting, they should be parallel for the best results. The conductor was sometimes suspended from the top of a cliff and earthed at the top end, instead of the bottom; thus at Alum Bay the wire hung 30 ft. out from the cliff and spoke to Bournemouth, 14 miles away. M. O'G.

1453. *Van Rysselberghe's Anti-Inductive Combination of Telegraphs and Telephones on Short Lines.* **M. Colard.** (Bull. Ass. Ing. El. Liège, 9. pp. 477–496, 1898.)—The analytical results shown in Bull. Ass. Ing. Elect. Instit., Montefiore, 1896–97, tome viii., series 2, p. 332, &c., are adopted, and the author concludes from a mathematical investigation (given in full) that the sinusoidal current in the line has maxima and minima intensities approaching 10 per cent. of the normal line current. He points out incidentally that electrostatic induction tends, in the conditions assumed, to produce in neighbouring telephone lines sounds which are approximately one-fifth lower in tone than those due to electromagnetic induction. The investigation practically results in a proof that in this anti-inductive system the currents and potentials are by no means of a simply damped form (as in a circuit containing only resistance and self-induction). The order of magnitude of the two chief oscillatory currents is calculated. M. O'G.

1454. *Intensity of Received Current in Van Rysselberghe's System.* **M. Colard.** (Bull. Ass. Ing. El. Liège, 9. pp. 497–515, 1898.)—The author assumes complex symbols for E.M.F's., current, and impedances, and thereby makes it legitimate to apply Ohm's and Kirchoff's laws to sinusoid currents as if they were direct. The calculations are done in full, and it is deduced that the line currents are at every instant equal and opposite. Hence, whatever current goes to earth by the condenser of one of the telegraphic stations comes back from the earth into the system by the other condenser, and the earth connection plays no part whatever. A further important conclusion is that for low frequencies the intensity of received current for the same impressed E.M.F. with Van Rysselberghe's system is greater than if the telegraphic instruments and their anti-inductive accessories were to be suppressed, provided always the capacities be retained. A numerical application is given, and the intensity of received current and lag are tabulated for various frequencies. Van Rysselberghe's system greatly increases the telephonic received current for women's voices. It is inferior for men's voices.

M. O'G.

1455. *Paper Telephone Cables.* **O'Gorman and Cozens-Hardy.** (Elect. Rev. 44. pp. 590 and 854, 1899.)—The specific capacity of paper used in telephone cables is 1·8. It is not possible to enclose 600 wires, 20 gauge, in a tube 2¾ inch diameter, and obtain a capacity of 0·08 mfd. per mile. Low insulation results from allowing the paper to be damp, but as the specific capacity of water is about 80 (for air = 1) for currents of telephone frequency, this had to be abandoned: 200,000 megohms per mile has also been obtained on long lengths without expense, but it is undesirable. The practice of making solid the ends of a cable with lead is criticised as well as the S type of paper insulation. [See 1899, Abstract No. 1255.]

W. R. C.

1456. *Telephone Exchange in Paris.* **G. de la Touanne.** (Journ. Télégraph, 22. pp. 121–126, 146–155, 193–200, 223–228, 1898.)—Drawings and diagrams and full-length explanations are given of a 9,000 subscribers' multiple exchange, designed and ordered in 1895 by the French Government.

M. O'G.

1457. *Recent Exchange Improvements.* **K. B. Miller.** (Elect. World and Elect. Engin. 33. pp. 469–471 and 502–503, 1899.)—An invention (by Thompson) is described which so arranges the cord circuits that an exchange equipped on the magneto-generator system may be worked during transformation into the new style, viz., central battery and automatic call (cp. Elect. World, December 24, 1898) without disusing either the new or the old parts of the exchange. A further invention (of Wales) to improve existing methods of connecting local lines in a common battery exchange with long distance or toll lines is described. The object is to avoid false signals, due to the calling subscriber hanging up his receiver, or the waiting subscriber's line not testing busy during the interval between the call and his connection. M. O'G.

1458. *Telephone Exchanges.* **H. P. Clausen.** (West Electn. 24. pp. 127–128, 1899.)—Diagrams and details are given of power-driven generators for signalling, both when the generator is kept in constant motion and when it is only put in action when required for a signal. M. O'G.

1459. *Telephone Party Lines.* **H. S. Webb.** (Amer. Electn. 11. pp. 81–84, 1899.)—Describes method for preventing a subscriber from listening on his receiver to a conversation going on between two others when his local bell has not rung. Connections for six subscribers with locking and unlocking devices are illustrated, also connections for eight subscribers without the locking devices. M. O'G.